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Essay on Earthenware and Porcelain.

[From Parkes' Chemical Essays.]

(Continued from p. 79.)

Before I proceed to a descriptive detail of the several processes in the manufactory of earthenware, it will be proper to say a few words on the nature of the different materials which are usually employed to form the body of the ware itself.

It is well known that the chief ingredients are clay and flint; the former of which, when pure, is known to chemists by the name of *alumina*, and the latter by the name of *silica;* and that no kind of earthenware can ever be perfect, unless it be made of a suitable sort of clay, and in that proportion only, which shall be correspondent to the quantity of flint employed. The experience of ages has confirmed this, and has proved that good pottery, as Vauquelin has remarked, differs from bad, less in the diversity of its elements, than in their proportions. How crude have been the notions of men respecting the chemical nature of bodies! The great Buffon "considered clay to be merely silica attenuated, and, as it were, rotted by the action of water, the air, and the sun."

Baumé was of opinion that sulphuric acid is a component part of all clays, and that the difference which is observable in different samples of this earth is chiefly owing to variation in the quantity of this acid—but this opinion is also erroneous.

There are four kinds of clay in common use in the Staffordshire potteries, and they are known by the following appellations, viz. *Black* clay, *Cracking* clay, *Brown* clay, and *Blue* clay. The two former are the produce of the south of Devonshire, the others are

brought from the Isle of Purbeck in the county of Dorset. With regard to the price of these clays, that of the two first is 14*s.* per ton, delivered on board the vessel, or 44*s.* when delivered in the potteries. The price of the two latter is 21*s.* on board, or from 48*s.* to 52*s.* per ton, when delivered to the works.

The *black clay* takes its name from the colour which it usually bears, and this is derived from a quantity of bitumen or coaly matter which it contains. This carbonaceous portion is, however, entirely consumed when the clay passes through the potter's oven, for the articles made with it become, when properly fired, of a good white.* It is, indeed, a curious fact, that the blacker this clay is when it is first dug, the more white will the earthenware be, which is made with it.

The second kind, called *cracking*, has acquired its name from a property which it has of occasioning the ware to crack during the first process of burning, or while making it into biscuit, if by accident a larger quantity than usual of it has been employed. But notwithstanding this singular property, the manufacturers are fond of it, on account of its extreme whiteness. It is, however, always dangerous to use it, unless it be employed with judgment, because it has a peculiar tendency to crack even when mixed with the usual proportion of silica. Every kind of clay, when dried without any admixture, will be liable to this inconvenience; because, if *pure* argillaceous earth be made sufficiently soft to be modelled by the potter's wheel, it will shrink one inch in twelve during the process of drying, and this will inevitably produce the effect in question.

The third kind which I have mentioned, is what is known by the name of *brown clay*. The excellency of this sort is, that it burns white, without danger of its cracking like the last species, although it is liable to another imperfection, which is termed *crazing*. Some manufacturers, however, employ this clay largely, while others, on account of this peculiar property, refuse it entirely.

Crazing is a technical term to denote the cracking of the glaze. It is believed that this generally arises from a defective union of the glaze with the body, owing to the clay, or the mixture of the clay with the other materials being ill calculated to receive the glaze properly. But may it not be occasioned rather by the glaze itself being not perfectly fusible? I suspect, however, that it more frequently originates from the circumstance of the ware being drawn out of the oven before it has time to cool gradually, and for the glass to become properly annealed. If lime be mixed with the materials which form the body of the ware, that will unavoidably occasion the crazing of the glaze.

The fourth kind, called *blue clay*, is considered to be the best, and, indeed, it always costs the highest price. This not only burns white,

* The Roman potters must have learnt that the native clays differ very much in their nature and properties, for they had different names to distinguish them; such as *Argilla* for potter's clay; *Terra pinguis*, black clay; *Leucargillion*, white clay; *Terra sigillaris*, fine clay; and *Tusconium*, the clay for crucibles.

but it forms a very solid kind of ware, and will bear a larger proportion of flint than any other; and it is well known to potters, that the greater the quantity of silica, the whiter will be the earthenware; though if more of this species of earth should be employed than the clay will admit, it would occasion the goods to crack in the second burning. Both this and the brown clay are now much used for making porcelain.

It requires much practice to be enabled to understand the nature of clays sufficiently to employ them in pottery to the best advantage. Dr. Lewis, in his notes to Neumann's Chemistry, has given the results of many experiments on the mixture of clay with the different earths, and earthy compounds, for the purposes of making pottery, which may be read with advantage by those who are desirous of investigating this subject. Chaptal speaks of a white earth from Ayoree in North America, which the French potters employ. Would not this be of equal value to our manufacturers?

Silica, or pure flint, as I have stated above, is likewise an important article in the manufacture of earthenware; forming, in general, a fourth, a fifth, or a sixth part of the whole of the bulk of the prepared mixture, or paste, when taken by weight.

There is, however, one remarkable difference in the properties of silica and alumina, which has a very manifest effect on porcelain. Pure silica is transparent; but the thinnest lamina of alumina is entirely opaque.

Alumina has such an affinity for silica, that it will unite with it even in the humid way, and form a kind of mortar, which will harden by time, and be afterwards incapable of decomposition by the action of the atmosphere. This combination is the basis of many of the gems and precious stones.

Much of the flint used in England, is brought from the neighbourhood of Larne, in the county of Antrim, in Ireland; but as this comes out of a bed of limestone, it is not so good for the potter's use as the chalk flint. The price of the latter is at this time about 35*s.* per ton, delivered in the Staffordshire potteries. The flint which is most approved is procured chiefly from Gravesend, where it is found imbedded in the chalk.* It is usually sold at 40*s.* per ton, delivered at the works.

The English potters procure their flint on these low terms, because the people who are employed in Kent, and the neighbouring counties, in getting the limestone and chalk, are obliged to raise the flint also; which being in their way, the proprietors of the quarries are glad to get rid of it even at a very inferior price.

It has been suggested by a friend of mine, that an inexhaustible source, for supplying the manufacturers with very excellent flint, would be the sea-shore; and that a person conversant with chemistry might readily examine a few samples of pebbles, and determine which were most suitable for making good pottery.

* Silica is also a component part of various other stones, and is the basis of rock crystal, quartz, agate, &c.

For making the finer kinds of earthenware, a considerable quantity of Cornish clay is also used, known commonly by the name of China-clay. This is the decomposed fel-spar of the granite; and it is prepared in Cornwall by the clay-merchants themselves, before it is transmitted to the Staffordshire potteries.

There are huge masses, or rather mountains, of white granite in Cornwall, and in some parts of the county, this is found to be partially decomposed; and it is where this is the case, that the mineral is raised and prepared for the purpose of making earthenware and porcelain, it having been discovered some years ago, by Mr. Cookworthy of Plymouth, that this mineral furnishes us with the true *kaolin*, and also with the *petuntse*, of the Chinese.

Granite is composed of quartz, fel-spar, and mica: and Mr. Gerhard found, in making an experiment on granite, that the fel-spar melted into a transparent glass; under it the mica lay in the form of a black slag, and the quartz remained unaltered.

To render the decomposing granite of Cornwall fit for the manufacturer, the following method is adopted. The stone is broken up by means of a pickaxe, and then thrown into a stream of running water. This washes off the light argillaceous parts and keeps them in suspension, whilst the quartz and the mica, thus separated, are allowed to subside near the place where the stone is first raised.

At the end of these rivulets are a certain kind of catch-pools, where the water is at last arrested, and time is allowed for the pure clay, with which the water is thus charged, to separate entirely from it. As soon as all the clay has subsided, the water is drawn out of these receptacles. The solid matter is then dug up in square blocks, and laid on what are called *linnees*, which are several connected series of strong shelves, erected so as to allow a proper circulation of air, in order that the clay may be more effectually dried for sale.

It is then packed in casks and sent to the Staffordshire potteries, and elsewhere, under the name of China-clay. Thus prepared, it is extremely white, and in the state of an impalpable powder. It may here be observed that none of the native clays are entirely free from foreign ingredients. If pure argillaceous earth be required, it can only be procured from alum, which may be dissolved in water, and then decomposed by an alkali. In this process, the pure clay will subside, which should then be thoroughly washed for use.

The price of these Cornish clays is considerably higher than that of any other kind; but for many of the finer purposes of pottery, they are absolutely indispensable. They are very smooth and ductile, and their extreme whiteness is very remarkable. It was analysed by Mr. Wedgwood, and found to consist of 60 parts alumina and 20 of silica.

The Cornish clay is also extremely useful for making crucibles, as it will not fuse by the addition of any of the common fluxes. In using these crucibles, however, they should always be put within others which are of little value; the inner ones will then acquire the heat gradually, otherwise they would be in great danger of breaking.

Besides the clays already mentioned, some of the Cornish granite

itself is often used with the clay, on account of the binding quality which it possesses, and its knitting, as it were, the other materials more closely, by its fusibility; it being naturally more fusible than the earths usually employed in this manufactory: for it is a curious fact, that neither clay, silica, nor lime, will melt singly; but by mixing these three species in due proportions, the greatest degree of fusibility is acquired.

Having thus briefly described the several articles which are most commonly employed in making pottery, it will now be necessary to explain in what manner these are separately prepared for use.

The flints are managed in this way: they are first burnt in a kiln, constructed for the purpose, and somewhat similar in form to a common lime-kiln; and then they are ground between very hard stones, by a great power, which is given either by the water-wheel or by a steam-engine. In constructing the apparatus, the purity and hardness of the stones are of very material consequence; for should they contain calcareous earth, a portion of this would be abraded during the grinding of the flint, which would prove very detrimental to the pottery of which it formed a part.

To enable the operator to expedite the process, and at the same time to grind the flints finer, a quantity of water is thrown into the mill with them, so that the article, when finished, has much the appearance and the consistence of cream. The health of the workmen is also preserved by this expedient; for, before this method was adopted, the atmosphere of the room often became charged with the finer particles of the flint, which, entering into the lungs, sometimes produced the most disastrous consequences.

The grinding the flint with water was first practised by the celebrated Brindley, well known for his skill in the construction of inland canals. The mills now in use were also invented by him; and are composed of a very hard siliceous stone, called chert, which is found in abundance in the neighbourhood of Bakewell in Derbyshire.

I have already hinted, that it is important to attend to the nature of the stone which is employed in these mills; and some years ago I was told of a very severe loss which was sustained by many of the large potters, in consequence of their having been supplied with great quantities of prepared flint which had been ground by stones containing a considerable portion of carbonate of lime, which being mixed with the flint, and eventually with the material itself, occasioned, to the body of manufacturers, a loss of many thousand pounds.

In order to prepare the clay, it is first mixed with water to the consistence of cream: the design of this is, that it may be the more easily passed through the sieves, and intimately united with the ground flint, which could not be done with uniformity, and certainty, if these earths were mixed dry.

The mixture of the clay and water, in the first instance, is generally effected by means of long wooden instruments, which the men move backwards and forwards with considerable force throughout the whole mass. It is an operation of great labour, and is distinguished by the term *blunging*.

The ground flint is mixed in a similar way, with water, and the stirring is continued until it become one uniform fluid mass. But these earths, the clay and the flint, are always blunged *separately;* because, if otherwise, and the two earths were mixed before being deprived of their impurities, which cannot be done till they are brought into a fluid state, it would be impossible to observe the requisite proportions of each.

The purification of these earths is effected by a process similar to that which the chemist calls Elutriation. When the earth has been well broken and thoroughly mixed with water, it is put into vats, or other large vessels; and when it has stood long enough for the grosser parts to subside, the fluid containing the finer particles is drawn off by a plug, and reserved for use.

In every preparation of these materials for the formation of earthenware or porcelain, it is of the utmost consequence to attend to the relative quantities of each: therefore, whenever these mixtures of the fluid clay with the flint are to be made, they are always done with some nicety, an attention being paid to the specific gravity of each of the fluids, which is either made heavier, or diluted further with water, as the case may require. The mixture of clay and water, after it has passed *once* through the sieve, is generally brought to the specific gravity of 24oz. the wine pint. A pint measure of the ground flint and water, when in the same state, is usually 32 ounces.

When the clay and the flint are mixed in suitable proportions, the whole mass, in this state of semifluidity, is passed through the sieves to take out any remaining impurities, and also to detain those particles which have not been sufficiently levigated. The mixture is then passed through the finest silk lawn, to ensure the certainty of no unbroken pieces remaining in it, and to reduce the whole to a state of the utmost uniformity and smoothness.

The next object is, to separate the water which has been employed with such profusion, and the readiest way of effecting this is found to be by the direct application of heat. The mass is therefore now poured into very long brick troughs, which are built with flues under them of a sufficient size to afford heat enough to produce an ebullition in the mixture; and this is continued until so much of the water is evaporated as will reduce the mass to the desired consistence.

The evaporation is, indeed, never carried beyond a certain point; because, if this mixture of the earths were allowed to become nearly dry, it would not be kneadable by the usual methods; neither could it be worked, by the hand, or the wheel, into any of those forms which it may be the intention, or interest, of the potter to impart to it.

I ought to have mentioned, that the mixture of the clay and the flint with water, is known in the trade by the name of *slip;* that the place in which it is kept is the *slip-house;* and the trough on which it is boiled is called the *slip-kiln.*

When the mixture has been thus brought to a proper consistence, it ought to be kept for a considerable time, that the materials may become more intimately united than they can ever be by mere me-

chanical force: but in general this is not much attended to, although every manufacturer is fully aware of its importance. Want of room, of time, and often of capital, occasions it to be sometimes used warm from the slip-kiln, and not uncommonly when it has been lying for a few hours, or days. In China, it is no unusual thing for the prepared clay to remain from 14 to 20 years, before it is thought to be in a fit state for use; and I have heard of some districts where it is customary for a father to prepare as much porcelain-clay as will be sufficient for the use of his son throughout the whole period of his life.

When the dried mass has been removed from the kiln, the next process is that of tempering it, which is effected by first beating it with mallets, and then turning it, and beating it again, and again, with small spades, or paddles, as the workmen call them, until it is thought to be as well tempered as it can be by these operations.

It should be recollected that this is not pure clay, but a mixture of all the ingredients. Vauquelin says that "Silex constantly forms at least two-thirds of most pottery; alumine from a fifth, to one-third; lime from one five-hundredth, to one twenty-hundredth part: and iron, from the minutest quantity, to twelve or fifteen per cent."

The mass, after the operation of beating, undergoes a process called *slapping*. For this purpose it is removed, in the state of large lumps, to a convenient bench or table, where a man having cut it across with a brass wire, unites it again by slapping one of the halves down upon the other, with all his force; he then cross-cuts it again and again, and as often unites it by main force, as before.

This cutting the clay in pieces and slapping it together, is a laborious operation; but it must always be continued until the air-bubbles, which the mass at first contained in great abundance, are all driven out of it; because, if the air was not thus carefully expelled from the clay, it would escape when it became rarified in the oven, and this would produce such blisters as would spoil the manufactured goods. On this account the slapping is continued until the mass exhibits, wherever it may be cut, a perfectly smooth and homogeneous surface.

Of late years Mr. Wedgwood and some other considerable potters have, however, employed an apparatus invented by Mr. Thomas Lowe of Nottingham, which effects all these purposes at once. It is moved by a steam-engine, and performs all these operations with a surprising economy of time and labour. It first breaks the burnt flint; it then grinds it in water, and another part of the apparatus performs the hitherto laborious operation of blunging* the clay in water, and breaking it into a semi-fluid and uniform mass. When this is done, it is run off and sifted by several sieves of different degrees of fineness, all which are moved by the same power. This earthy fluid then runs down to a lower room, where it goes through other sieves in the same way. In like manner, another part of the appa-

* This is the technical term, but doubtless it is a corruption of the word *plunging*.

ratus squeezes the dried clay, to save the expensive operation of *slapping*, described at page 151; after which it passes to an iron cylinder, full of knives, where it is cut into pieces with great expedition; which saves the expense of cutting it by hand with brass wires, as before mentioned. This receptacle is not properly a cylinder, but a large hollow inverted cone of iron, and the knives are fixed in an upright shaft which revolves within it and passes through its centre. These knives are so contrived that the clay, as it is cut, is forced lower and lower by every revolution, until at last it is pressed by the power of the machinery through a square hole near the bottom of the apparatus, from whence it is removed as it falls, and is carried in blocks to the other parts of the manufactory.

The clay having undergone those varied operations, it is now fit for being formed into any shape, or employed for any purpose, for which it is designed. Accordingly, it is fashioned into various forms by means of a variety of moulds made of plaster of Paris; or put into as great a diversity of shapes by the potter's wheel.

[TO BE CONTINUED.]

ESSAYS ON BLEACHING.

By James Rennie, A. M., Lecturer on Philosophy, &c. &c. London.

No. IV.—CHEMICAL AND PHYSICAL NATURE OF STUFFS.

(Continued.)

2. *Wool.*—For our knowledge of the texture and composition of this important material of the cloth manufacture, we are greatly indebted to Detubenton. The qualities of wool as to length and tenuity of fibre, vary according to the parts of the animal whence it may have been taken; to the breed of sheep from which it is produced; the climate where they live; the pasture where they feed; and according as the animals are healthy or diseased. That which grows on the neck, the sides, and the back, is the finest part of the fleece, and fortunately the most abundant. The best breeds are found to degenerate in certain climates, and certain pastures, of which we have an illustrative instance in the European breed, in some places of America, which now produce hair, instead of wool. This seems to depend on the same general principle with the effects produced on wool by the diseases of the animals, the most healthy always affording the best—for change of climate, and food, may alter the constitutional secretions, as much as disease. Great attention has lately been paid in Britain to those circumstances which affect the qualities of wool, and great improvements have been made by the sheep farmers. This is of much importance, as we are indebted to Spain for all our finest wools. As the fineness of wool cannot be accurately ascertained by simple inspection, the manufacturer ought to compare by means of a microscope, the different specimens which may be offered to his purchase. When the wool is in its natural state, it is protected from moisture by a substance of a soapy nature, called *yolk* by the English, and *eek*

in Scotland. This, according to M. Vauquelin, (Ann. de Chim. xlvii. 276,) consists of a basis of potash combined with an animal oil, together with lime united to the carbonic, acetic, and muriatic acids. This nutritious matter is always most abundant on the wool of healthy sheep.

Mr. Mushet found, that after distilling in the dry way 180 grains of pure white wool, there remained a residuum coal, of a dark shining gray colour, welded, or caked, into one mass, adhering in part to the sides of the retort. It weighed only 43 grains, having lost in distillation 137 grains. In 100 parts, therefore, are contained 76 volatile matter, and 23.89 oxide of carbon.

The mechanical structure of wool is worthy of attention, both as an object of curiosity, and as, probably, of some importance in explaining the rationale of bleaching it. This structure was first described by the abbe Monge, (Ann. de Chim. vi. 300;—see also Nich. quarto Journ. i.) he having discovered it when examining the process of fulling. According to this philosopher, the fibres of wool consist, either of *laminæ* lying in a slanting manner upon one another, from the root to the extremity, somewhat like the scales of a fish, or of a series of rings gradually decreasing in diameter from the root to the point, and overlapping one another, as in the horns of animals. M. Monge states, and his statement is repeated by Bancroft, and in the Edinburgh Encyclopedia, that this structure may be perceived by drawing a fibre between the thumb and finger, from the point towards the root, in which case a tremulous motion, it is said, will be distinctly felt, accompanied with a sensible grating noise. Now I am disposed to controvert this; for upon repeated trials, with fibres of every degree of fineness, I could neither feel the motion nor hear the grating. This cannot even be perceived in the coarse hairs of cows and horses, though those have a similar structure. The only way by which it can be made sensible, is with a microscope, or by putting a hair between the finger and thumb, and moving them gently one upon another, when the fibre will move forward, or backward, according as the point, or the root, is placed anterior, or posterior, to the part by which it is held. This property of hairs has been long known to some of our peasants, who take advantage of it to excite the wonder of the ignorant, by telling the root, or the point, of any hair, although it be cut into ever so many pieces. It is on this structure that fulling and felting depend; it is to smooth the asperities caused by it, that spinners grease their wool; and it is in the interstices of these laminæ, that the colouring matter, which it is our object to find a method of removing, is lodged. The laminæ seem to be elastic, and, consequently, the pores must be dilatable by heat. This it may be useful to remember.

3. *Cotton.*—This substance is a down contained in the pods of the *gossypia* of Linnæus. This down is different in the different species, both in fineness and colour. In most it is white, of different shades; but that from which the nankin is made, is what Werner would call Sienna yellow, or bufforauge: a sort is mentioned as growing in Dahomy of a bright yellow; and several kinds, having

different shades of red, have been described. The coloured sorts, however, are not common, and the chief difference between one sort and another, seems to consist in the length, tenuity, and strength of the filaments. Naturalists do not seem to have ascertained with accuracy, the structure of these filaments. The microscope, according to Lewenhoeck, shows that they have two sharp sides. It certainly possesses some kind of asperities, or how can we account for the irritation which it produces when used in dressing wounds? In this it is totally different from lint. Perhaps this irritating action may be accounted for from the filaments being shorter than those of flax, and consequently presenting a greater number of points on the surface of the cloth. Dr. Thomson found the specific heat of cotton to be 0.53, that of water being 1, but from the difficulty of ascertaining this, he does not state it with confidence. (Ann. of Phil. II. 27.)

We learn something of the composition of cotton from Mr. Mushet's experiments on dry distillation. (Phil. Mag. XXXIII. 9.) He distilled 263 grains of the cloth which had been previously bleached. It emitted, during the operation, a quantity of pale blue flame, and left, as a residuum, a light friable coal, possessing the original shape and texture of the cloth, which weighed 39 grains—loss, 124 grains. It appears, then, that a hundred parts consisted of 85.16 volatile matter, and 14.84 of carbon; being 16.16 less carbon than is contained in as much silk, and 9.05 less than exists in pure wool.

The fibres of cotton, according to Nicholson, (Dict. of Chem. art. vegetables,) are insoluble in water, in alcohol, or in ether; but soluble in alkalies. It follows, of course, that strong alkaline leys will injure the texture of cotton goods in the process of bleaching. When treated with the nitric acid, cotton yields the oxalic. There seems to be in cotton, none of that particular resinous kind of matter which constitutes or contains the colouring matter of unbleached linen.*

4. *Linen.*—The mode of preparing flax, for the linen manufacture, has already been cursorily mentioned, when treating of water, and I shall not repeat what was then stated. The flax, when taken from the field, is put into ponds of standing water to steep, and stones are laid above it, to keep it from floating. When no such ponds are to be had, it is put into those parts of running water where there is little current, or little streams are banked up for the purpose. None of these, however, answer so well as ponds, for the process is both more tedious and more uncertain. The intention of steeping is to dissolve the oily or mucilaginous substance which makes the bark adhere to the woody part of the flax, and thus to effect a separation of the latter. This intention is answered by the putrefactive fermentation,

* Des Charmes, however, (p. 106,) ascribes to such a resin, or to an oil or a gum, existing in cotton, the difficulty with which it imbibes water. Des Charmes remarks also, that though it may not appear foul, yet it never fails to render, by its impurities, the water in which it may be macerated, of a darkish colour. As it imbibes water with difficulty, it also retains it with some obstinacy, and before bleaching, is found to be long in drying. This may be countenanced by an observation of Mr. T. Henry's, (Man. Mem. iii.) that it imbibes water much more readily after it has been bleached than before.

which steeping induces, for it renders the oil and the mucilage soluble in water. It requires some nicety, however, to know when the putrefactive process has accomplished its purpose, for the flax will be equally useless if it has been steeped too much, or too little. In the one case the fibres will not be separable, or black bars in the linen will be the consequence, whose numbers increase with the deficiency in steeping, and which, in bleaching, are very difficult to remove. In the other, they will be destroyed, or very much weakened, by losing their tenacity. Now, the length of time which flax has been in the pond, can give no criterion of this, for the putrefactive fermentation depends much on other circumstances, such as the nature of the flax, its quantity, the heat of the weather, the length of the nights, the pressure of the stones laid upon it, and the quality of the water. The quickness or slowness of the fermentation, then, must be the measure of the time of steeping. On the second or third day, when the weather is warm, a great many air bubbles arise to the surface of the water, and a scum, or pellicle, is gradually formed. The temperature of the water increases, and it acquires a corrupted smell. The flax ought to be inspected every six hours, after the fourth day; and as soon as a glutinous or oily matter is perceived on the outer bark, and when this separates easily from the woody part, it ought to be taken out. But it ought not to lie till this separation becomes too easy, as this will be better completed by exposing it to the dew. Steeping ought always to be performed in a place much sheltered from the winds, as the process is checked by nothing so much as by agitation and cold, while it is greatly promoted by quietness and heat. For this reason also, the ponds ought not to be too shallow, as in that case they are more liable to be affected by changes of temperature. The flax ought not to touch the bottom of the pond, otherwise what is below will perhaps be rotten, in consequence of the superincumbent pressure, before that at the surface is nearly watered. This process appears, then, to be extremely difficult in management; and by it is produced a great deal of that brown colouring matter, which it is the object of the bleacher to remove.* Mr. Lee's method of preparing flax, which has been before stated, is not liable either to difficulty of management, nor to its injurious effects, and bids fair to supersede the process of steeping, altogether.

The nature of the colouring matter of brown linen, whether it exist naturally in the flax, or be acquired by steeping, has been accurately investigated by Dr. Kirwan, in the Transactions of the Royal Irish Academy, Vol. III. He made his experiments upon ley, satu-

* With regard to colours so produced, Chaptal has made a general remark of some importance, namely, that all colouring matter, arising from fermentation, are less soluble in water than in alkalies. He illustrates this by referring to the well-known dye-stuffs, indigo, woad, and annotta. Boiling water dissolves only a ninth part of its weight of indigo; woad communicates very little colour to water; and annotta can scarcely be dissolved in it at all without the aid of an alkali. Water, then, it will follow by analogy, confirmed, as we shall immediately see, by experiment, will have but little effect on the colour acquired by flax in the putrid fermentation induced by steeping.

rated with this matter, which he procured from the bleachers. This liquor was turbid, of a reddish brown colour, having a strong smell and exhibiting no indication of acidity, or alkalescence. It did not effervesce with the muriatic acid, but afforded with it a copious precipitate, leaving a supernatant liquor of a red amber colour. When this is drawn off by a syphon, and the precipitate treated pretty copiously with water, agitating the whole, and again allowing it to subside, the floating liquor exhibits evident signs of acidity, and continues reddish, giving room to suppose that it contains a peculiar acid. After copious effusions of cold water, and when the precipitate is thrown on a filter and suffered to dry partially, it is of a dark greenish colour, and nearly of the consistence of moist clay. This was not dissolved when treated with sixty times its own weight of boiling water. If dried in a sand heat, it assumes a shining black colour, but when broken, shows a greenish yellow fracture, and becomes more brittle. On this the following experiments were made: 1, Having digested a portion of it in rectified spirit of wine, it communicated to it a reddish hue, and was in a great measure dissolved; but by the effusion of distilled water, the solution became milky, and a white deposite was gradually formed: the black matter dissolved in the same manner. 2, Neither the green nor the black matter was soluble in oil of turpentine, or linseed oil, by a long continued digestion. 3, The black matter being placed on a red hot iron, burned with a yellow flame and a black smoke, leaving a carbonaceous residuum. 4, The green matter being put into the sulphuric, muriatic, and nitric acids, communicated a brownish tinge to the two former, and a greenish to the latter, but did not seem in the least to be diminished. We infer from this, that the matter extracted by the alkalies from brown linen, is a peculiar sort of resin, differing from the pure resins only by its insolubility in essential oils, and agreeing in this respect with lacs. In examining the action of alkalies on this matter, 8 grains of it were digested in a solution of crystals of soda, saturated to the temperature of 60°, which instantly communicated to the solution a dark brown colour; two measures, each of which would contain 11 dwts. of water, did not entirely dissolve this substance. Two measures of mild vegetable alkali, dissolved the whole. One measure of caustic soda, of the specific gravity of 1.053, dissolved nearly the whole, leaving only a white residuum. One measure of caustic potash, of the specific gravity of 1.039, dissolved the whole. One measure of liver of sulphur, (sulphuret of potash or soda,) whose specific gravity was 1.070, dissolved the whole. One measure of caustic volatile alkali, dissolved also a portion of this matter. Three ounces of the solution of Windsor soap, dissolved 8 grains of the colouring matter. It was found also that 4.2 grains of the saline substance of kelp, produced the same effect as 75 of that from Dantzic pearl ash, 38 of that from barilla, 15 of that from cashup, and 213 of soap. The sulphuret of lime was found to act very feebly on it. It follows from these experiments, that sulphuret of potash, or soda, is of all the alkaline compounds the strongest solvent of the colouring matter; next to this the caustic vegetable, and

after this the caustic mineral alkali; the mild alkalies occupy the least place. Hence, the solutions of kelp, cashup, and markoff, are advantageously used in the first processes of bleaching, for which Dantzic ashes and sweet barilla are less fit. The experiments, however, show that six tons of kelp will be necessary to produce the same effect as one ton of cashup.

It was found by Mr. Mushet, that flax contained more carbonaceous matter than cotton. His experiments were made by dry distillation. When he treated 397 grains of flax in this way, after a copious discharge of white flame, a soft inflammable coal was left as a residuum in the retort. The original vegetable fibre remained entire, and equally compact as to form and bulk, as when introduced. It weighed 65 grains, having lost by the process 332 grains. A hundred parts are therefore composed of 83.62 volatile matter, and 16.38 of carbon. (Phil. Mag. XXIII. 8.)

No. V.—Processes followed in Bleaching.

Section I.

By the arrangement which I have adopted, many of the details which, in most of the treatises on Bleaching are given under the present head, have been anticipated, a circumstance which, I hope, will render our account of the processes more perspicuous than it could otherwise have been made; it will, at least, make it shorter. An outline of the processes of bleaching followed about half a century ago will be found in the history, p. 207, vol. ii. by comparing which with the following, an idea may be formed of the rapid march of improvement. I begin with the processes for bleaching piece goods and heavy cotton cloths, which do not materially differ, except in the repetition of immersions, the cottons requiring fewer than the linens.

1. *Steeping.*—This process is intended to remove, without the expense of fresh alkaline ley, the impurities which the goods may have contracted in passing through the previous stages of manufacture from the spinner and the weaver, and which the subsequent management might tend to fix. Flax is mostly spun by hand, and the spinner constantly moistens it with saliva to make it draw out more readily to the proper grist. Now as saliva is known to be a more universal solvent than even water, we may infer that many impurities may, by this means, be fixed in the yarn. It will also, from its nature, form, when dry, a pellicle of tenacious matter on the surface of the threads, and may thus prevent the solvents from coming into contact with the colouring matters which are lodged in the body of the thread. Cotton again being spun by jennies and throstle frames is not liable to such regular contamination, but it is sometimes stained by the oil which is used for the machinery. Both are also filled with impurities by the weaver, who finds that he cannot make good work, unless he previously dress the yarn with some gelatinous matter that may give it a stronger adhesion. The linen weaver commonly uses for this purpose a sour paste, made from the seeds of oatmeal, which is applied with a brush to the yarn; and then tho-

roughly dried in, by passing a hot iron over the web. He then takes a brush, on which he has rubbed a small quantity of tallow, and goes over the whole. The cotton weaver seldom uses the flummery paste, but prefers one made of flour, or of mashed potatoes in a state of fermentation, and sometimes a mixture of both: and the combustibility of the cotton will not permit him to use so expeditious a mode of drying, as the hot iron affords. He dries his web with a large fan, and afterwards goes over it with the grease brush, in the same way as the linen weaver. I was astonished to read in Mr. Parkes' Essays on Bleaching, (Vol. IV. p. 121.) that the weaver "*melts a quantity of grease over his warp, which he afterwards spreads with a brush:*" a thing which I am persuaded no weaver would ever be so foolish as to try, as the parts where the grease fell would do away all the effects of the previous dressing. For this reason, weavers are always very careful not to rub too much grease on their brushes. Mr. Parkes must therefore find some more likely account of the origin of copper stains.

The small quantity of grease in the cloth, is fixed by the subsequent operation of singeing, when this is had recourse to; and if this is not taken out in the previous processes of bleaching, it will not yield afterwards to the usual processes of ashing and souring.

For the removal of these impurities, the first thing to be done is to have the cloth thoroughly washed, (with soap if necessary,) by the dash wheel, to get rid of what may be loosely attached to it. If time can be spared, it would render this washing more effectual to have the goods disposed in very open folds, to prevent unequal compression, and soaked in water, either in a trough, or in a running stream. (Des Charmes, p. 95.) They are next placed in similar foldings in a kieve which is filled with water, or waste alkaline, or soap leys, at a blood heat, with which they must be sufficiently covered, and held down by the cross bars formerly described; for they soon begin to swell and rise above the surface when this is neglected. Osier twigs must be placed at the bottom to prevent this swelling from causing too much pressure. A smaller degree of heat than that mentioned would not readily dissolve the dressing, and a greater might coagulate and fix it in the cloth. In a short time the dressing mixes with the water, and from its previous acidity induces the acetous fermentation. An intestine motion becomes perceptible, the temperature increases, and air bubbles are emitted, which by carrying up to the surface some of the light oleaginous particles, produce a thick scum. These effects, however, are gentle, and slow, as the dressing is in small quantity, in proportion to the water. The acid salts, according to Dr. Home, are no sooner separated by the acetous fermentation, from the absorbent earth which made them not perceptible to the tongue in their former state, than they are united to the oily particles of the tallow, which likewise adhere superficially, dissolve them and render them in some degree miscible with water. In this state they are soon washed off by the intestine motion of the liquor. This fermentation continues from twelve to eighteen hours, according to the state of the weather; but even in summer may be allowed, if

we may trust Des Charmes, to go on without inconvenience for forty-eight hours. It is known to have continued the proper time, when an infinity of white bubbles are seen on the surface, and a fœtid smell is perceived; or when the goods have assumed a clear yellowish colour, instead of gray or brown. When no more air bubbles rise to support the scum, it separates, is precipitated, and would again become attached to the cloth, if not timeously removed. But greater danger may be apprehended from the putrid fermentation taking place, which would both weaken the texture of the cloth, perhaps rot it, and also generate and fix a dark colouring matter, that it might be difficult afterwards to remove. Attention to the indications now given will prevent such serious accidents.

There has been some discussion and difference of opinion respecting the liquid most proper for steeping. Waste alkaline leys are most commonly used, from our idea that they produce the strongest fermentation; but this, if it be the case, may arise from the impurities with which they are loaded. For fine calico bleaching they certainly ought not to be used, as indelible stains may be the consequence. The alkaline salts may attract the acid salts generated by the fermentation, and prevent their combination with the oleaginous impurities. On the contrary, if the alkaline salts are not previously saturated they may be of use in combining with, and carrying off the tallow. Dr. Home tried to come to some decision on this subject, but his experiments proved unsatisfactory. Des Charmes used milk of lime with advantage. He allowed the goods to remain in this liquid not longer than five or six hours, when they were found sufficiently prepared for the subsequent processes. Water, however, when time can be spared, is as efficacious as either this or an infusion of bran, which has also been recommended—to this a decided preference is given in Ireland.—(*Dub. Rept.* 1791.)

When the goods are found to be sufficiently steeped, the *steep* is to be drawn off and the goods taken to the squeezers, in order that all the loosened impurities may be pressed out. They are then taken to the dash wheel and washed till the water come off clear, when they are either wrung to such a degree that they may remain only moist, or are left to drain, on a proper stage. After rinsing or clearing piece goods subsequent to steeping, particular attention ought to be paid to rubbing them well with black soap, especially along their selvages, for this part being closer wrought than the rest requires to be particularly cleared to open it to the action of the succeeding detergents. When this is not attended to, it may probably be necessary, after the several operations, to rub them separately by hand, and the bleaching would be retarded by requiring several extraordinary immersions, to prevent these parts from being less perfectly white than the rest. Cottons which have received stains of oil are best cleared by a hot solution of black soap.

NATURAL HISTORY.

THE BEAVER.

[From Dr. Godman's Natural History.]

(*Continued from p.* 104.)

The beaver is a cleanly animal, and always leaves the house to attend to the calls of nature; the excrement being light, rises to the top of the water and soon separates and disappears. Thus, however great may be the number of individuals occupying the hut, no accumulation of filth of this kind occurs.

The beaver swims to considerable distances under water, but cannot remain for a long time without coming to the surface for air. They are therefore caught with greater ease, as they must either take refuge in their vaults or washes in the bank, or seek their huts again, for the sake of getting breath. They usually, when disturbed, fly from the huts to these vaults, which, although not so exposed to observation as their houses, are yet discovered with sufficient ease, and allow the occupant to be more readily captured than if he had remained in the ordinary habitation.

To capture beavers residing on a small river or creek, the Indians find it necessary to stake the stream across to prevent the animal from escaping, and then they try to ascertain where the vaults or washes in the banks are situated. This can only be done by those who are very experienced in such explorations, and is thus performed:—The hunter is furnished with an ice-chisel lashed to a handle four or five feet in length; with this instrument he strikes against the ice as he goes along the edge of the banks. The sound produced by the blow, informs him when he is opposite to one of these vaults. When one is discovered, a hole is cut through the ice, of sufficient size to admit a full grown beaver, and the search is continued until as many of the places of retreat are discovered as possible. During the time the most expert hunters are thus occupied, the others, with the women, are busy in breaking into the beaver houses, which, as may be supposed, from what has been already stated, is a task of some difficulty. The beavers, alarmed at the invasion of their dwelling, take to the water and swim with surprising swiftness to their retreats in the banks, but their entrance is betrayed to the hunters watching the holes in the ice, by the motion and discoloration of the water. The entrance is instantly closed with stakes of wood, and the beaver instead of finding shelter in his cave, is made prisoner and destroyed. The hunter then pulls the animal out, if within reach, by the introduction of his hand and arm, or by a hook designed for this use, fastened to a long handle. Beaver-houses found in lakes and other standing waters offer an easier prey to the hunters, as there is no occasion for staking the water across.

Among the Hudson's Bay Indians every hunter has the exclusive right to all the beavers caught in the washes discovered by him. Each

individual on finding one, places some mark, as a pole, or the branch of a tree stuck up, in order to know his own. Beavers caught in any house, are also the property of the discoverer, who takes care to mark his claim, as in the case of the washes.*

The number of beavers killed in the northern parts of this country is exceedingly great, even at the present time, after the fur-trade has been carried on for so many years, and the most indiscriminate warfare waged uninterruptedly against the species. In the year 1820, 60,000 beaver skins were sold by the Hudson's Bay Company, which we can by no means suppose to be the whole number killed during the preceding season. If to these be added the quantities collected by the traders, from the Indians of the Missouri country, we may form some idea of the immense number of these animals which exist throughout the vast regions of the North and West.

It is a subject of regret, that an animal so valuable and prolific, should be hunted in a manner tending so evidently to the extermination of the species, when a little care and management on the part of those interested, might prevent unnecessary destruction, and increase the sources of their revenue. The old beavers are killed within a short time of their littering season, and with every such, from three, to six, are destroyed. The young are often killed before they have attained half their growth and value, and of necessity long before they have contributed to the continuance of their species. In a few years, comparatively speaking, the beaver has been exterminated in all the Atlantic, and in the western States as far as the middle and upper waters of the Missouri; while in the Hudson's Bay possessions they are becoming annually more scarce, and the race will eventually be extinguished throughout the whole continent. A few individuals may, for a time, elude the immediate violence of persecution, and like the degraded descendants of the aboriginals of the soil, be occasionally exhibited as melancholy mementos of tribes long previously whelmed in the fathomless gulf of avarice.

The Indians inhabiting the countries watered by the tributaries of the Missouri and Mississippi, take the beavers principally by trapping, and are generally supplied with steel-traps by the traders, who do not sell, but lend or hire them, in order to keep the Indians dependent upon themselves, and also to lay claim to the furs which they may procure. The name of the trader being stamped on the trap, it is equal to a certificate of enlistment, and indicates, when an Indian carries his furs to another trading establishment, that the individual wishes to avoid the payment of his debts. The business of trapping requires great experience and caution, as the senses of the beaver are very keen, and enable him to detect the recent presence of the hunter, by the slightest traces. It is necessary that the

* Lewis and Clarke relate an instance which fell under their observation, of one beaver being caught in two traps, belonging to different owners, it having one paw in each. The proprietors of the traps were engaged in a contest for the beaver, when the above named distinguished travellers arrived, and settled the dispute between them, by an equitable arrangement.

hands should be washed clean before the trap is handled and baited, and that every precaution should be employed to elude the vigilance of the animal.

The bait which is used to entice the beavers is prepared from the substance called castor *(castoreum)* obtained from the glandulous pouches of the male* animal, which contain sometimes from two to three ounces. The substance is called by the hunters bark-stone, and is squeezed gently into an open mouthed phial.

The contents of five or six of these castor bags are mixed with a nutmeg, twelve or fifteen cloves, and thirty grains of cinnamon, in fine powder, and then the whole is stirred up with as much whiskey as will give it the consistency of mustard prepared for the table. This mixture must be kept closely corked up, and in four or five days the odour becomes more powerful; with care it may be preserved for months without injury. Various other strong aromatics are sometimes used to increase the pungency of the odour. Some of this preparation, smeared on the bits of wood with which the traps are baited, will entice the beaver from a great distance.

The castor, whose odour is similar to tanners' ooze, gets the name of *bark* stone from its resemblance to finely powdered bark. The sacks containing it are about two inches in length. Behind these and between the skin and root of the tail, are found two other oval cysts, lying together, which contain a pure strong oil, of a rancid smell.

During the winter season the beaver becomes very fat, and its flesh is esteemed by the hunters to be excellent food. But those occasionally caught in the summer, are very thin, and unfit for the table. They lead so wandering a life at this season, and are so much exhausted by the collection of materials for building, or the winter's stock of provision, as well as by suckling their young, as to be generally at that time in a very poor condition. Their fur during the summer is of little value, and it is only in winter that it is to be obtained in that state which renders it so desirable to fur traders.

The different appearances of the fur, caused by age, season, disease, or accident, have at times led individuals to state the existence of several species of beaver in this country. No other species, however, has yet been discovered, but that whose habits we have been describing. Beavers are occasionally found nearly of a pure white, which is owing to the same cause that produces albino varieties of various animals. A specimen of the albino beaver may be seen in the Philadelphia Museum. *Hearne* saw but one such specimen during a residence of twenty years in the Hudson's bay country. This was considered a great curiosity, and no other was afterwards procured there during the ten ensuing years, notwithstanding he offered a large reward to the Indians for as many of the same colour as they could procure.

The traits of character exhibited by the beaver in captivity, are not very strikingly peculiar, though sufficiently interesting. It learns

* Juxta preputium introque latere existunt.

to obey the voice of its master, is pleased to be caressed, and cleanly in its habits. Hearne states that he has kept various individuals about his house, during his residence at Hudson's bay, and remarks, "they made not the least dirt, though they were kept in my own sitting room, where they were the constant companions of the Indian women and children, being so fond of their company that when the Indians were absent for any considerable time, the beaver discovered great signs of uneasiness, and on their return showed equal marks of pleasure by fondling on them, crawling into their laps, laying themselves on their backs, sitting erect like a squirrel, and behaving to them like children that see their parents but seldom." In general during the winter they lived upon the same food as the women did, and were remarkably fond of rice and plum-pudding. They would eat fresh venison and partridges very freely, but I never tried them with fish, though I have heard they will at times prey on them.*

[TO BE CONTINUED.]

FOR THE FRANKLIN JOURNAL.

On the causes of the inadequate protection afforded by Lightning Rods, in some cases, and the means of insuring their perfect competency: also, a refutation of the prevalent idea, that Metals are peculiarly attractive of Electricity. By R. Hare, M. D., *Professor of Chemistry in the University of Pennsylvania.*

In some of our American newspapers, a letter has been republished from the London Times, calculated, as I conceive, most perniciously to lessen the confidence of the public in metallic conductors, as a mean of protection against lightning. In common with many other persons, the author of the letter appears to suppose, that metals are peculiarly attractive of electricity; and infers that, when a metallic rod is attached to a house, or ship, a discharge of electric fluid may be induced from a cloud, which, otherwise, would not have been sufficiently near to endanger the premises. Nothing in my opinion can be more erroneous than this notion. The truth is, that the earth, and the thunder clouds being in opposite electrical states, the electric fluid tends to pass from one to the other, in order to restore

* "It is well known that our domestic poultry will eat animal food; thousands of geese that come to London market are fattened on tallow craps, and our horses in Hudson's Bay would not only eat all kinds of animal food, but also drink freely of the wash or pot-liquor intended for the hogs. We are assured by the best authorities, that in Iceland not only black cattle, but also the sheep, are almost entirely fed on fish and fish-bones during the winter season. Even in the isles of Orkney, and that in the summer, the sheep attend the ebbing of the tide as regularly as the Esquimaux curlew, and go down to the shore which the tide has left, to feed on the sea-weed. This, however, is through *necessity*, for even the famous island of Pomona will not afford them an existence above high water mark." *Hearne*, 8vo. *p.* 245. It must always be borne in mind that observations made on the diet of captive animals will not at all apply to them when they are free to follow the dictates of nature. It is, however, highly interesting, to know how far they can accommodate themselves to necessity.

the equilibrium. The atmosphere being a non-conductor, through which a discharge cannot be accomplished without a forcible displacement of air, any solid body rising above the earth's surface, which may be more capable than the air, of transmitting electricity, is made the medium of communication. Metals being pre-eminently capable of acting as conductors, the transmission of electricity is made through them, with proportionably greater facility. Yet they do not attract it more than other substances, similarly electrified. A glass, or wooden ball, is as readily attracted, by the excited conductor of an electrical machine, as a ball of metal; and as much more, than a metallic point, as the superficies of the ball, may be greater, than that of the point.

Nothing, to me, appears more unfounded than an idea, lately suggested, that the attraction between a ship, and a thunder cloud, can be increased, by the presence of a pointed metallic rod, surmounting the main-mast.

If houses, or vessels, have been struck with lightning, while provided with conductors, it is, in my opinion, owing to the conductors being improperly constructed; or having no adequate connexion with the earth. The power of any body to receive an electric discharge, is dependent on the conducting power of the medium in which it terminates, no less than upon its own. A metallic rod, held by a glass handle, or entering a mass of pounded glass, or dry sand, would not be more efficacious, as a conductor, than a glass rod similarly situated. If terminated by an imperfect conductor, as for instance by earth, or water, its power is reduced in proportion to the imperfection of the medium thus bounding it. This influence of the media, in which conductors terminate, has not been sufficiently insisted upon, in treatises on electricity. I should not consider a metallic rod, terminating, without any enlargement of surface, in the water, or the earth, as an adequate protection against lightning; but were such conductors to terminate in metallic sheets, buried in the earth, or immersed in the sea, or, *by a connexion duly made with the iron pipes, with which our city is watered, or the copper with which ships are generally sheathed,* I should have the most perfect confidence in their competency.

It is not only important that the points of contact, between the metallic mass, employed to afford lightning an adequate passage, and the earth, or water, in which it terminates, should be so multiplied as to compensate for the inferior conducting power of the earth, or water; but it is also necessary that the conducting rod be as continuous as possible. When conductors are to be stationary, as when applied to buildings, they should consist of pieces screwed together, or, preferably, joined by solder, as well as by screwing. Where flexibility is requisite, the joints should be neatly made, like those of the irons in fall top carriages; and should be rivetted so as to ensure a close contact at the junctures.

In all cases, the ordinary, but important, precaution of having the rod to terminate above, in a fine clean point, should be attended to. Where platina tips cannot be had, multiplying the points by split-

ting the rod into a ramification of pointed wires, may compensate for the diminution of conducting power, arising from rust.

The efficacy of the point, or points, is, however, dependent on the continuity of the conductor of which I have already spoken: since it is well known, that, if a pointed rod be cut into parts, so as to produce intervals, bounded by blunt terminations, its efficacy will not be much greater than if it had no point; because the fluid will, in that case, pass in sparks, instead of being transmitted in a current. It is on this account that I object to chains, or rods joined by loops, or hooks and eyes. The error of supposing that a metallic rod, must be more capable of attracting electricity injuriously, because of its known wonderful power in transmitting it, will be evident, when it is understood that the only difference between metals and other bodies, arises from the superior power of transmission. Hence, when by a defective communication with the earth or sea, the efficacy of the metal, as a conductor, is diminished, or destroyed, its influence over a charged cloud is proportionably lessened. It follows, therefore, that so far as it acts, its action must be beneficial, unless its lower termination should, by an inconceivable degree of ignorance or inattention, be so situated, as to render it more easy for the electrical fluid to leave the rod, and pass through a portion of the house or vessel, than to proceed, by means of the rod, into the earth or sea.

Thus Richman was killed by a conductor which he employed to receive electricity from the clouds, and to convey it to an electrometer, necessarily insulated: under these circumstances, the head of the professor being about a foot from the conductor, he became a part of the channel of communication with the earth. Had the apparatus been surrounded by a cage of wire, and this duly connected with a metallic rod soldered to a sheet of metal buried in the earth, Richman might have made his observations with perfect security. That with due precaution, experiments, analogous to his, are not productive of injury to the operator, is rendered evident by the subjoined quotation from Singer's Electricity.

I must premise, that the apparatus, by means of which the phenomena alluded to were produced, consisted of a wire a mile long, supported and insulated, upon very high poles, and terminating in the house of the electrician, Andrew Crosse, Esq.

"The approach of a charged cloud, produces sometimes positive, and at others negative signs, at first: but, whatever be the original character, the effect gradually increases to a certain extent, then decreases, and disappears, and is followed by the appearance of the opposite signs, which gradually extend beyond the former maximum, then decrease, terminate, and are again followed by the original electricity. These alternations are sometimes numerous, and are more or less rapid on different occasions; they usually increase in intensity at each repetition, and at last a full dense stream of sparks, issues from the atmospherical conductor to the receiving ball,* stop-

* That is, a ball communicating with the earth, by an adequate metallic conductor.

ping at intervals, but returning with redoubled force. In this state a strong current of air proceeds from the wire and its connected apparatus; and none but a spectator can conceive the awful, though sublime, effect, of such phenomena. At every flash of lightning, an explosive stream, accompanied by a peculiar noise, passes between the balls of the apparatus, and enlightens, most brilliantly, every surrounding object, whilst these effects are heightened by the successive peals of thunder, and by the consciousness of so near an approach to its cause."

"During the display of electric power, so awful to an ordinary observer, the electrician sits quietly in front of the apparatus, conducts the lightning in any required direction, and employs it to fuse wires, decompose fluids, or fire inflammable substances; and when the effects are too powerful, to attend to such experiments securely, he connects the insulated wire with the ground, and transmits the accumulated electricity with silence, and with safety."

FOR THE FRANKLIN JOURNAL.

Remarks upon Water Wheels, and upon some prevailing errors respecting the Application of water as a Motive Power.

I SUPPOSE that, at the present day, no man who professes to be capable of directing the construction of a water wheel, or of estimating the amount of a water power, is ignorant of the fact, that water falls through a distance of about sixteen feet in the first second. But I suspect that many who assume the above qualifications, do not know the ratio of increase, either of the distance, or the velocity. I have drawn this conclusion, not only from conversations with several practical engineers, but also from essays published in our scientific journals. As an instance of the latter, I will select, for its convenience of reference, an article on water wheels published in this Journal (Vol. I. p. 103.) which being the production of a practical engineer, and having passed the inspection of a scientific committee, may be considered as corroborating my commencing observations. In the third paragraph of that article, is the following sentence: "As a falling body, water descends at the *speed* of nearly 16 feet in the first second, and it will appear evident, that if a water wheel is required to be so driven, that the water with which it is loaded has to descend 10, 11, or 12 feet per second, at which rates wheels are generally constructed to work, that a *very large proportion* of the power is lost."

Here, in the first place, we find *speed*, or *velocity*, confounded with the *distance* fallen in the first second; whereas, the latter is 16 feet, and the former is accelerated, from nothing, at the commencement, to 32 feet per second, at the end of the first second; so that this part of the sentence conveys, strictly, no intelligible meaning; it is, nevertheless, made a standard, by a comparison between which, and any

given velocity of a water wheel, we are to infer the loss of power sustained through excess of speed; thus, in the case of a wheel whose velocity is 10, or 12, feet per second, comparing these numbers with the mysterised number 16, the writer concludes, "that a very large proportion of the power is lost." The height of the fall which indicates the whole amount of the power, is not mentioned, but surely, to estimate the *proportion* between a defined part, and an undefined whole, is impossible.

The vague appreciation of first principles which I impute to this writer, is exhibited conclusively, in his closing remarks on certain establishments which he had inspected. At the corn mill on the Rariton, as well as at the flour mills on the Brandywine, he represents the fall of water to be 20 feet, the diameter of the wheels about 16 feet, and the speed of their skirts about 10 feet per second, worked by a head of 4 feet; from which he draws the deplorable conclusion, that "in all these establishments there is not obtained 50 per cent. of the power of the water used." But, a little simple arithmetic will furnish the proprietors of these mills with a more satisfactory account, and, perhaps, prevent their incurring the expense of a new arrangement, with a view to realizing the lost 50 per cent. of their power.

The velocity of the skirts of the wheels is 10 feet per second; this velocity is acquired by water in a descent of 18¾ inches.* But the water issues upon the wheels from under a head of 4 feet, under which its effluent velocity is 16 feet per second. Now, although the wheels are not much assisted by the impulsive power of the water, striking upon them with a velocity 6 feet greater than their own, yet they are certainly not retarded by it, and therefore, on no ground can we make the loss more than 4 feet; which is but one-fifth of the whole power or fall of 20 feet, leaving four-fifths as the proportion of the power effectively applied, instead of less than one half, as asserted in the article under consideration.

Our water works at Fair Mount, which so justly excite the pride of our citizens, and their gratitude to those public-spirited individuals to whose enterprise and skill we are indebted for them, come next in review; but as his information on some important points in this case, is incorrect, I need not enter into an examination of his conclusions; I will however, venture to offer my own views on the subject of the economy, and application, of the power consumed.

The head and fall, at high tide, is 6 feet 6 inches, the wheel, at this time, wading 2 feet in the tide; when the tide is out, it is 8 feet 6 inches, and as the tide rises and falls about 6 feet, twice in 25 hours, I suppose the wheels wade, more or less, for about 7 or 8 hours out of every 24; I will therefore, take the average head and fall, to be 8 feet.

The velocity of the skirts of the wheels is 12 feet per second, which is due to a fall of 27 inches. The water issues upon the wheel from under a head of 12 inches; its effluent velocity is, therefore, 8 feet per second; but, the direction given to it by the form of the aperture

* See the table, p. 169.

through which it issues, is at an angle of about 45 degrees with the breast of the wheel, of course, its velocity in the direction in which the skirt of the wheel moves, cannot be more than 5¼ feet per second; but as the wheel moves at the rate of 12 feet per second, it must expend some of its power in impressing its own velocity on the water.* The whole loss of power may be estimated thus:—

The velocity of the wheel 12 feet per second, is acquired by water in falling, - - - - - - - - - - 27 inches.

The water issues on the wheel from under a head of 12 in.

Its velocity in the required direction is 5¼ feet per second, which is due to a fall of 5⅔ in.

The difference is so much lost, viz. 6⅓ inches.

Total loss 33⅓ inches.

Or thus:—

The velocity of the water in the required direction, is that which is due to a fall of 5⅔ inches.

Immediately on striking the wheel, it receives a velocity due to a fall of 27 inches.

The difference, indicates the power expended by the wheel, in giving it that velocity, - - - - - - - - 21⅓ inches.

The water comes on the wheel below the surface of the dam, - - - - - - - - - - - - 12 inches.

Total loss as before, 33⅓ inches.

Thus it appears, that of the whole power expended, one third is lost by the excess of speed, and the manner in which the water is introduced into the buckets; and two thirds are effectually applied to the work.

The height through which the water is raised, from the dam to the reservoir, is 96 feet; the water which raises it, falls 8 feet; therefore, supposing that all the power could be effectually used, and no loss sustained on account of leakage, friction, &c. 12 gallons on the wheels descending 8 feet, should raise 1 gallon to the reservoir, 96 feet; whereas, every gallon that reaches the reservoir, costs an expenditure of between 30 and 40 gallons from the dam. Suppose the average expenditure to be 36 gallons, to raise 1 gallon; then, but one-third of this power is accounted for at the reservoir; and as I have shown that one-third is lost by the excessive velocity of the wheel, &c. the remaining one-third must be charged to friction, leakage, &c. This last third, however, is one half of the effective power.

I have made a calculation of the distances, and velocities, attained by falling bodies, in various fractional parts of a second, which is here introduced, for the information of those practical, and theoretical, engineers, who have avoided the labour of doing it for themselves.

* Every visiter at Fair Mount must have noticed the noise produced by the percussion of the floats of the wheels, upon the water entering the buckets.

I have proceeded on the following established data, viz.

Heavy bodies fall through a distance of 16 feet, in the first second; at the end of which, they have acquired a velocity of 32 feet per second.—The velocity increases as the times.—The distance increases as the squares of the times.

Time of Descent.	Distance fallen. ft.	Distance fallen. inches.	Velocity attained per sec. ft.	Velocity attained per sec. inches.
1	0	$0\frac{1}{256}$	0	3
2	0	$0\frac{1}{31}$	0	6
3	0	$0\frac{9}{256}$	0	9
4 } 128ths of a sec.	0	$0\frac{3}{16}$	1	
5	0	$0\frac{2}{7}$	1	3
6	0	$0\frac{9}{32}$	1	6
7	0	$0\frac{3}{8}$	1	9
2	0	$0\frac{3}{4}$	2	
3	0	$1\frac{2}{3}$	3	
4 } 32nds of a sec.	0	3	4	
5	0	$4\frac{2}{3}$	5	
6	0	$6\frac{3}{4}$	6	
7	0	$9\frac{1}{4}$	7	
1-4th of a sec.	1	0	8	
9	1	$3\frac{1}{6}$	9	
10	1	$6\frac{3}{4}$	10	
11	1	$10\frac{2}{3}$	11	
12 } 32nds. do.	2	3	12	
13	2	$7\frac{2}{3}$	13	
14	3	$0\frac{3}{4}$	14	
15	3	$6\frac{2}{11}$	15	
1 half of a sec.	4	0	16	
17	4	$6\frac{1}{3}$	17	
18	5	$0\frac{2}{3}$	18	
19	5	$7\frac{2}{3}$	19	
20 } 32nds. do.	6	3	20	
21	6	$10\frac{2}{3}$	21	
22	7	$6\frac{3}{4}$	22	
23	8	$3\frac{1}{3}$	23	
3-4ths of a sec.	9	0	24	
25	9	$9\frac{1}{3}$	25	
26	10	$6\frac{3}{4}$	26	
27	11	$4\frac{2}{3}$	27	
28 } 32nds. do.	12	3	28	
29	13	$1\frac{2}{3}$	29	
30	14	$0\frac{3}{4}$	30	
31	15	$0\frac{1}{3}$	31	
1	16	-	32	
2 } seconds.	64	-	64	
15	3600	-	480	
30	14400	-	960	
1 minute.	57600	-	1920	

To determine what *proportion* of a given water power, is lost by a given velocity of the wheel, it is only necessary to ascertain, what distance the water must descend to acquire that velocity. Then, this distance compared with the whole fall, answers the question. Thus: suppose the whole fall to be 10 feet, and the velocity of the wheel 4 feet per second; this velocity is due to a fall of 3 inches, or one-fortieth part of the whole fall, which is the proportion sought. Or, suppose the velocity to be 13 feet per second, which is due to a fall of 2 feet 7⅞ inches, then the loss is rather more than one-fourth of the whole fall of 10 feet. But, it must be especially noted, that these estimates embrace the supposition, that the water issues upon the wheel in the direction of the motion of its skirt, and precisely at that distance below the surface of the dam, which answers to the velocity of the wheel. Inattention to this particular, is a very important, and frequent, cause of loss. L. M.

Animadversions on Mr. Genet's Reply to "Remarks on his Memorial on the Upward Forces of Fluids;" with additional observations on the merits of that work. By the EDITOR.—[*Continued from p.* 111.]

"Leave not a wreck behind."

In our last number we examined the high pretensions of Mr. Genet, to extensive information on the subject of the steam-engine, and will now ask the attention of our readers, to a few remarks upon his projected *improvements* in navigation and aerostation; and if we do not greatly mistake, we shall convince the phrenologists, that we have *the organ of destructiveness* completely developed.

We had been led to anticipate a very formidable reply to our strictures, published in January last; Dr. Pascalis having, some time since informed a mutual friend, that the proofs of our ignorance would be made to stand out in bold relief. The Doctor, we apprehended, would continue to sustain the character which he had assumed, as the champion of his friend, against those who are "not even qualified to bestow either praise or censure;" many of our remarks having been elicited by the bold tone of his communication in Dr. Silliman's Journal. Mr. Genet, however, informs us, that the task of defence devolves upon himself exclusively, from the determination of his friend "to observe only silence;" convinced, no doubt, that the better part of valour, is discretion. The cause of our being thus *sent to Coventry* by the Dr. is set forth by Mr. G., who, speaking of our remarks, says, "But how great was my surprise, at finding that nearly the whole of this new production of his pen, was in a great measure calculated to involve in my proscription, our worthy friend DOCTOR PASCALIS, SENIOR CENSOR OF THE STATE MEDICAL SOCIETY OF NEW YORK, AND PRESIDENT OF THE AMERICAN BRANCH OF THE LINNÆAN SOCIETY, and to hold us both up to

public view, as fit subjects for ridicule; the one, for having advanced an untenable doctrine, and the other, for having in some measure countenanced it, by claiming for its author, on a subject entirely new, a suspension of censure and condemnation, until the whole scheme could be matured, and rectified, by actual experiment." We again protest against confounding the man and his projects; we have, ourselves, our moments of hallucination, and may therefore be in danger of suffering under a violation of this rule.

That the doctrines which one of these gentlemen has advanced, and which the other has boldly advocated, are fallacious, and ridiculous, it has been our object to prove; and in so doing, we have been labouring in our proper vocation. From the untenable nature of the premises assumed by them, the task has, necessarily, been an easy one; we, nevertheless, did expect something less puerile, and more imposing than the "Reply" before us. We shall not tax the patience of our readers, by noticing one half of the errors which it contains, but as we have entered the lists, we intend to make secure, the position which we have taken.

It will have been seen that Mr. Genet asserts, that his friend Dr. Pascalis has only "claimed for its author, [the memorial] on a subject entirely new, a suspension of censure, and condemnation, until the whole scheme could be matured, and rectified, by actual experiment." Let us, however, hear the claims, in the words of the Dr. himself, and learn if they are thus limited. In Vol. XI. p. 112, of Dr. Silliman's Journal, he says, "Mr. Genet undertakes to apply the aerostatic power to the raising, or lowering, of canal boats, on an inclined plane, between a water level, and a higher level, with or without water. He will propel boats on a high level, destitute of water, and lower them to a water level. He can raise or lower carriages on rail ways, from one level to another—relieve steam boats, stranded or grounded, &c. Combining also aerostatic and hydrostatic powers, he can raise or lower canal boats, to or from, a high vertical altitude; raise vessels stranded, and other heavy bodies, from under water, also on land, by means of hydrostatic cranes. He can direct how to prevent ships from sinking, &c. and finally, he will protect, or guard steam boats, against snags, sawyers, shoals and rocks,"

And we, "can call spirits from the vasty deep," but then, they will not come when we do call them; and we apprehend, that, unless the voice of Mr. Genet be seconded by means more efficient than those presented in his memorial, he will find that matter, is, sometimes, as disobedient as spirit.

The basis upon which the assumptions of our author are built, is, that *there is a force in fluids, which urges them in a direction contrary to that of gravity*; and that in consequence of this *upward force*, and independently of the general laws of atmospheric pressure, the motion of a balloon, in ascending, is accelerated as the atmosphere grows lighter, and its pressure decreases: and that hitherto, this *Upward force*, or "*force of levity*," has been entirely overlooked, or neglected.—Caloric, or the matter of heat, is assumed to be this

principle of levity; it is said, that it "gives levity to ponderosity, changes the laws of gravity, and denotes by its tendency to re-ascend to its centre of circulation, that gravity is not a positive, but a negative force, that it is not an active, but a passive agent." These are "the new natural powers, put in requisition," and for the application of which, Mr. Genet has obtained a PATENT.

We have looked, in vain, for a single fact, tending to prove the correctness of these assumptions; they stand therefore, in the same predicament with the assertion that, two and two make five; and it certainly would not be deemed wise to enter into an elaborate argument to disprove such an assertion, merely because some estimable, but wrong headed individual had made it. The "Preliminary principles, facts and authorities," (Memorial p. 12 to 22,) furnish no data whatever in support of the existence of his "New natural power," but contain, with the exception of many of those errors in philosophy, which are so thickly scattered over its pages, a number of admitted facts, and principles, relative to specific gravity; atmospheric pressure; pressure of water; aerostatics; mechanical powers, &c. It was in this part, if any where, that we ought to have been informed, why balloons, if made air tight, should not, after they have reached that point where they shake off their mundane coil, obey implicitly the principle of levity, by which they are elevated, "tending to re-ascend to its centre of circulation," the sun, and fly off to that luminary. Why the atmosphere itself, and all other gaseous bodies, should not rise from the surface of the earth, and, borne upward by their *specific levity*, seek the same centre of circulation; and why, if balloons rise because "Fire ascending seeks the sun," they will yet ascend at midnight, and consequently depart from their centre of attraction. Mr. Genet has repeatedly complained, that those who have opposed his views, have made assertions without offering proofs, but, excepting to one in his novitiate, it would be idle to attempt to offer proofs in support of principles generally received. It is Mr. Genet who has failed in this particular; he has boldly attempted to establish a new principle of specific levity; has denied the universality of gravitation; has declared that gravity is not an active, but a passive agent; and made many other assertions equally vague and fallacious, and seems to expect to sustain himself in so doing, by sounding titles, without advancing a single step in that rigorous course of experiment, or induction, which true philosophy demands.

Plate 1st, in the Memorial, and in the analysis published by Dr. Pascalis, is a representation of *an aerostatic elevator to raise and lower canal boats, on an inclined plane.* The force to be applied in the drawing up of canal boats, is the ascent of an air balloon, (*an aerostat,*) which is to act by means of a rope fastened to the bottom of it, and passing through a sheeve, or pulley, and thence up to the periphery of a large wheel, thirty feet in diameter. A pit is dug, at the bottom of which is the aforesaid pulley, the laboratory in which the hydrogen gas is to be prepared, &c. Over the whole, a building is to be erected, sufficiently extensive to contain the large wheel and its appendages; and sufficiently high to allow of the ascent of the

aerostat. "In reference to the building and its dimensions, if an ascension of 90 feet, producing 900 feet distance, equivalent to 90 locks, was really wanted, the altitude from the bottom of the pit, to the top of the cupola, ought to be 96 feet, allowing six feet under, to attend to the balloon and gas." (Memorial, p. 29.) The balloon, according to the estimate made, if covered with *silk*, and forty-five feet in diameter, will possess an ascensive force of 3236 lbs., about *a ton and a half*; and a canal boat with its load, is estimated to weigh *sixty tons*.

Waiving all remarks upon the total ineligibility of the power proposed to be applied as the first mover, as there is little danger that any engineer, or mechanician, will make an essay of it, we will repeat the question which was originally asked by the Editors of the Boston Journal, "But why not use the descendent force of a leaden weight, as well as the ascensive force of an air balloon?" a question which it has not been convenient for Mr. Genet, or his friend, to answer. The balloon after it has ascended, is to be drawn down again; we beg pardon, "recalled down;" and, this naturally suggests the inquiry; how much less power will *recall* it down, than that which it exerted in its ascent? and why not use this power to draw up another boat, without troubling the balloon?

In calculating the power requisite to draw a boat of sixty tons, up a plane, with a rise of one foot in fifteen; Mr. Genet estimates it at 3200 lbs. Now we had understood, though, to be sure, it was according to the *exploded* philosophy, that in order to *sustain* a weight upon an inclined plane, the power so sustaining it, must bear the same proportion to the weight, which the perpendicular height of the plane, bears to its length; and that, consequently, in the contemplated plane, it must be equal to one fifteenth of the load of sixty tons, that is 8,000 lbs. instead of 3,200; a *trifling* difference, and easily obviated by enlarging the house, the balloon, and the laboratory, to considerably more than double their proposed capacity; but even then, the whole will be at rest, as we have yet to overcome friction, and to give motion; to effect which, another addition must be made to the power, which shall suffice to increase it to about four times the estimate.

When compared with some accompanying estimates, the foregoing exhibits but a slight deviation from correctness, as will appear upon examining the operation of the wheel thirty feet in diameter, and, in the round numbers of Mr. Genet, *ninety* feet in circumference. The rope, or chain, which is to draw up the boat, is to pass over a drum, or drums, of twenty feet in diameter, or *sixty* in circumference; the large wheel is to drive a pinion on the drum shaft, and give to the drums, fifteen revolutions, for one of the large wheel, so that the periphery of the drums will travel with ten times the velocity of the large wheel, or through 900 feet, whilst that of the large wheel travels 90, and of course, if the balloon be allowed to ascend 90 feet, it must draw the boat 900 feet. It is rather an inverted procedure in mechanics, to drive a pinion, by a wheel of fifteen times its size; but the object to be gained is very great indeed; no less than to cause

a power of 3236 lbs. moving through a space of 90 feet, to raise 60 tons to the perpendicular height of sixty feet. According to the *exploded* philosophy, 80,000 lbs. or twenty-five times the amount assigned in the Memorial, would just balance the sixty tons. How mighty are the Upward forces!

For the mode of filling the aerostats, *instantly*, with the *coal gas*, Dr. Pascalis refers to the Memorial: anxious to learn how this was to be effected, we carefully examined the work, but alas, it was in vain.

"*To propel boats on a high level destitute of water, and to lower them to a water level,*" is the next scheme; it is the child of the former, and, resembling it in so many of its features, may be dismissed in a few words. There are to be rail-ways, with balloons and buildings, fixed as before, for raising the boats to a summit level; other balloons are to be placed, with similar appurtenances, at suitable distances from each other, and these, in their ascent, are to draw the boats along; after which, the balloons are to be successively "recalled down," that they may renew their labours.

"*To relieve steam boats stranded, or grounded.*" The boats are to be furnished with empty balloons, which are to be filled, *instantly* of course, with "ignited air," *cooled by passing it through water*, and with *coal* gas; which gases, we are told, are in general dissipated without any advantage. This ignorance of the very alphabet of chemistry, was not to be anticipated, from learned doctors, and philosophers of the present day. Coal gas in the chimney of a steam engine! This is a discovery of Mr. Genet's, of which, ignorant wights, his masters in chemistry and philosophy never dreamed; they might have looked there for carbonic acid, and nitrogen, and would have expected to find but little else; and with these they never would have thought of filling aerostats, excepting to promote the art of sinking.

Passing over various other projects for employing the same means, we come to the "*applications of the aerostatic and hydrostatic powers combined.*" Mr. Genet has, it seems, performed some experiments, by means of an instrument, which he calls an HYDROAEROSTATOMETRE; a hollow tin vessel filled with air, and of the capacity of half a cubic foot. By the use of this instrument, he professes to have ascertained, that, using the old French standard, of 70 lbs. to the cubic foot of water, the *upward force* of the instrument, when immersed in water, was 100 lbs. for every cubic foot. Although this is 30 per cent. more than could be obtained by any other philosopher, we may let it pass, as this difference will add but little to the efficiency of his machines.

The *hydroaerostatometre*, gives birth to the *hydrostat*, which, in principle, is the same with the *aerostat*, substituting copper for silk, atmospheric air for hydrogen, (or for carbonic acid, and nitrogen,) and water for atmospheric air. The *hydrostat*, is, in fact, a copper vessel filled with air, and is to be used "to *raise*, or LOWER, *vertically*, *canal boats*, *to a* HIGH ALTITUDE." (Memorial, p. 39.) This copper vessel, is, in the example given, to be a spherical balloon of fifteen feet in diameter, and it is said, will contain 15,000 feet of

air, and allowing the 30 per cent. before given in, and reckoning nothing for the weight of the copper, the chain, &c. is to be pressed by the upward force of water, with a power of 150,000 lbs. or 75 tons. This copper ball is to be placed in a well into which water, when wanted, may be admitted. This well is to be 16 feet broad, and thirty feet deep; in it, the *hydrostat* is to be capable of rising to the height of *ten feet*, and by means of a rope or chain, like that of the *aerostat*, is to raise a canal boat, weighing seventy-five tons, to the height of *one hundred feet;* its power being increased ten fold, by causing a large wheel to turn a pinion $\frac{1}{10}$ of its diameter. To those who would be capable of understanding them, comment and reasoning are here unnecessary.

Several other applications of this *new* power are proposed, which we need not notice, as they are mere variations of that just given; we proceed therefore, to the *hydronaut*, in which it is to be used as a substitute for the steam engine. It will be seen from the remarks of Mr. Genet in his 'Reply,' that we had selected this as the principal object of notice, in our Journal, for January last. We will repeat a part of those observations, and add a few others on the same subject; but first, let us hear our author speak for himself. In his Memorial, after having noticed the reciprocating motion in the steam engine, he says, (p. 62.) "How can I procure the same alternate motion of the hydrostat? By immersing it alternately in two different fluids, air and water; but as a single hydrostat could not accomplish that object, and procure an alternate motion, rapid enough to perpetuate the rotatory motion, two must be employed; and by so doing, there will be no disparagement between the steam, and the hydrostatic engine; since it is well known that it has been found necessary to introduce two cylinders in the steam engine, to perfect the rotatory motion, and replenish the deficiency of a single cylinder."

Mr. Genet, as usual, errs when speaking of the steam engine, it being "well known" that, although two cylinders have been sometimes used, it has *not* been found necessary to introduce them "to perfect the rotatory motion, and replenish the deficiency of a single cylinder;" and that they have been abandoned, in nearly every instance, excepting in the loco-motive carriage. This gentleman is perpetually haunted by the ghost of the atmospheric engine, and must in his *numerous observations*, have mistaken the air pump, for a second steam cylinder.

We selected the hydronaut as the object of our former animadversions, because, of the whole series of proposed machines, we deemed it the most absurd. In the others, although totally inadequate to the production of the intended effects, there is a capacity for motion; but in this there is no principle of action, whatever; otherwise, it would be, to all intents, a *perpetual motion*, in the ordinary acceptation of that term. It is to operate without the application of any extrinsic force; no fuel is to be expended; no springs to uncoil; no weights to descend; no animal power, wind, or running water, to be used; nothing in fine but the principle of alternate, *absolute*

levity. The thing is simply to be suspended in air, and water; is there to commence running, and to "navigate until it is stopped." When a man undertakes to construct a perpetual motion, and at the same time thinks himself a philosopher, we must leave *him* to himself; and if it be thought worth while to treat the subject with any degree of seriousness, it is only for the sake of the confessed tyro.

For the description of this apparatus, as given by Mr. Genet, we must refer to his Memorial, or to the analysis of it by Dr. P. and the accompanying plate in Dr. Silliman's Journal. We have described it, in the article already referred to, in our January number, and to save trouble, we here repeat our description.

"The *proposed* moving power of the hydronaut, consists of two hollow copper vessels, called *hydrostats;* they are to be cylindrical, with conical ends, perfectly closed; these are to be suspended upon a beam, twenty-four feet long, resembling that of a steam engine, and are to hang below it, similar to a pair of scales upon their beam. These hydrostats, are to be contained within two cylinders, which stand under the beam, and in which they may freely rise and fall, when the beam vibrates. These cylinders are to be open at top, and to have a valve in the bottom of them, to open a communication with the water in the river; by some means, (what means we cannot discover,) water is to be made to flow, alternately, in and out of these cylinders; that which contains water, will have the *hydrostat* immersed within it, forced up by its buoyancy, that at the opposite end, being allowed to descend, in consequence of the removal of the water; and so on, *ad infinitum.* The machinery by which it is intended to remove the water, is to be worked by the same beam. This machinery consists principally, of two pumps, oddly enough, called air pumps; their piston rods are attached to the beam, they being placed within the main cylinders; to the beam is also appended the apparatus for opening and shutting the valves; a piece fourteen feet in height, ascends from its centre, and from the end of this, a rod passes, which is to act upon a crank, and give motion to paddle wheels, whilst by the intervention of a *large wheel turning a pinion,* the velocity is to be increased. Should any one wish for a model of this machine, he may make it, by suspending an egg-shell upon each end of a small scale beam, these will be his *hydrostats;* then by taking two glasses of water, and passing them alternately upwards against the shells, he will cause the beam to vibrate; and if he can then only contrive to attach to the beam, something which will relieve his hands from the task of moving the glasses, he will have contrived a perpetual motion, exactly upon the principle of that of Mr. Genet. Should he be at a loss to see how this is to be done, we must refer him to the inventor, as we cannot direct him even with the aid of the engraving, and the book. 'So the *hydronaut* will navigate until it is stopped,' say the gentlemen concerned; we however, feel inclined to transpose the sentence, and to say, 'so the hydronaut will stop until it is navigated.'"

However ludicrous the machine may appear, as represented in the proposed model, Mr. Genet does not, and cannot deny, that, so far

as it goes, the picture is a correct one; and that it would be completed by first allowing the tumblers to stand in a vessel containing water, so that this fluid might rise on the outside of them, to the same height at which it stood within, or to the same height at which it would stand, were their bottoms perforated; and then, if we can, causing the beam to work two pumps, and two valves, which shall alternately exhaust the tumblers of their water, and alternately allow them to fill; the beam must do this perpetually, until it be forcibly stopped; it must also produce a large excess of force, which, in the actual machine, is to give "power superior to the effective and disposable force of any steam boat navigating the ocean." Mr. G. further says, that between this and the steam engine "there is no difference but simplicity and economy."

Before proceeding to notice the grand project of a balloon, we will direct the attention of our readers, to a very interesting editorial paper on aerostation, which follows Mr. G.'s reply in the last number of Dr. Silliman's Journal; we have read this article with great pleasure, and coincide in opinion, with the learned author, in almost every point; we also concur with him in the spirit of his concluding remarks, but are far from thinking that the case in hand, is one to which they legitimately apply; he says, "We conclude by wishing Mr. Genet ample success. Failure will involve no disgrace, but success would add another brilliant leaf to the book of discovery." Although we doubt the practicability of steering balloons in the air, we have not the temerity to say that it is impossible, and we would cheerfully aid, and gladly witness, an experiment for the attainment of this object, provided the means indicated, were not, palpably, inadequate. But were some person to propose to elevate an aeronaut by the "specific levity" of carbonic acid; or to raise a load of seventy-five tons, to the height of one hundred feet, by the descent, or ascent, of a power of seventy-five tons, to the distance of 10 feet; we should feel ourselves disgraced in the eyes of every man of science, were we not to condemn the project in the most unqualified terms; and here also we undoubtedly agree, with Dr. Silliman.

"*The aerostatic vessel, or aeronaut,*" appears to be Mr. Genet's greatest favourite. We cannot attempt to point out the numerous fallacies respecting it, which are contained in the memorial, but will merely make a few remarks upon the main point, the proposed means of propulsion; and even on this, we shall offer but a small number of the objections which present themselves. Mr. Genet proposes to navigate his balloon by the power of two small horses, each equal to 100 lbs., making conjointly 200 lbs. In this estimate he has left out of view, that most important function of their power, velocity. His two small horses, would be able to draw the weight assigned, with a velocity of only two and a half miles per hour; yet with them he is to move sails, which, according to his own calculation, are to "produce a pressure of 4200 lbs. *per minute* upon the air." Now according to the vulgar arithmetic, by which other philosophers have made their estimates, this would exceed the power of these horses 20 fold; but Mr. Genet says, that their power "being multiplied by 21 revo-

lutions of the air wheels in one minute, will produce a pressure of 4200 lbs." The same principle prevails here, as in his other machines; power and speed, are both to be obtained, by making large wheels act upon small ones.

The small power which we have assigned, say $\frac{1}{20}$ of that claimed, will be reduced to less than nothing, by making a very moderate allowance for friction, and by the want of propelling power in the paddle wheels, a main feature in the apparatus. These wheels, which are estimated to act upon the air with a force of 4200 lbs. per minute, are each to be furnished with sixteen wings, or fins, five feet in length, and two and a half in width. Eight of these on each side, are to act at once, the other eight being doubled up, within a case, or curb, to prevent their neutralizing those which are in action. Allowing it to be practicable to fold in these wings, without an immense loss of power, let those of our readers who possess either the Memorial, or the Journal, turn to the plate, and see what will be the action of the eight which remain; that is, what portion of their power will be employed in urging the balloon forward. It will be at once perceived that the wings which are first liberated, tend to drive the aeronaut back, just as much as those below, tend to drive it forward, and that the only apparent effect, would be to elevate it, by the descent of those which are intermediate. We are a little surprised that this case, or curb, was not placed upon the top; this certainly would have been an improvement, at least, as regards the apparent power of propulsion, for although the thing would still have been nearly powerless, it would have looked as though it might possess power.

Before closing, we will offer another mode of estimating the power of the horses, founded upon data, given by Mr. Genet. A section of the aeronaut, the car, the wheels, &c. would measure about 2500 square feet. A brisk breeze, according to a table given in the Memorial, travels at the rate of about eleven miles per hour, and exerts a force of about eight ounces upon every square foot, this upon 2500 feet, would be 1250 lbs.; and this therefore is the force, which when a brisk breeze blows, tends to carry the balloon, eleven miles per hour. This is equal to the power of about 60 of Mr. Genet's horses; and were it not for the intervention of his *wheels and pinions*, it would be necessary to employ, at least, this number, notwithstanding the bird-like form of his balloon.

But after all, may not the aeronaut burst? The probability of this is confessed; but although, without freight, passengers, or *additional horses*, the articles taken up are estimated to weigh 13,400 lbs. Mr. Genet assures us that "the downfall would be as light as a feather," as he is confident that the whole would form an immense parachute. Should he err as widely in this estimate, as in those which have preceded it, the consequences might be very serious; and for ourselves we aver that we will not, if invited, consent to ascend, unless one of the horses be assigned to us, and he be of the Hypogryf breed.

Account of a new Scheme of Perpetual Motion, invented by SIR WILLIAM CONGREVE, *Baronet.* With remarks by the EDITOR.

WE apprehend that our readers will conclude that we have said enough respecting the upward forces of fluids; still we are tempted to present this subject in a new form, and must again urge the apology, that although we think the scheme, about to be presented, worthless, it derives some claim to notice, from the standing of the individual who is its author. Sir William Congreve is a member of the British Parliament, and claims to be a man of science, and an engineer. He is the inventor of the rockets which bear his name; and which during the late war, were much more effectual in alarming our women and children, than in injuring our forts, or soldiers. He was also the contriver of a clock, which was intended to look like a perpetual motion. We saw one of them in Raleigh, some three or four years since: it was a pretty looking toy, but worse than useless, as it kept a ball in motion, which served only to injure the going of the clock. We might enumerate several other abortive schemes, which have given celebrity to his name, but will notice only one other before explaining his last project. He was the most active opponent of our countrymen Perkins and Fairman, in their mission to England, for the purpose of introducing their plan for preventing the counterfeiting of bank notes. In this opposition he succeeded, so far as to prevent their employment by the bank, and to secure to himself the business of the stamp office: this latter has, however, been recently taken from him, and given to Perkins and Heath, as may be seen by the letter of the former gentleman, published in our June number. This letter contained some details upon this subject, which we thought it best to omit, in laying it before the public.

We have been induced to make the foregoing remarks as a necessary preface to the account of the perpetual motion, for which we understand Sir William has obtained a patent; and which, we apprehend, is that announced in the list of English patents, p. 69. "To Sir William Congreve, Baronet, for his having invented a new motive power, 8th February." This, we have no doubt, will add another to the list of this gentleman's abortive labours, and to the catalogue of those persons whose grasp the phantom, perpetual motion, has eluded, at the moment in which they have thought it secured; still there is a considerable display of ingenuity in some of his proposed arrangements, and, it is to be regretted, that this ingenuity has not been directed to some purpose of practical utility.

The drawings which we have given, will fully explain the manner in which the power is expected to be obtained. It is necessary, however, to premise, that in the wheels represented in figs. 4 and 5, which are to be surrounded by a band of sponge, there is to be an apparatus to squeeze the water out from one side of this band, whilst on the opposite side it rises by capillary attraction.

The first part of the following account is from a report on this subject, published in the *Atlas;* and the remainder, from a pamphlet issued by the Baronet.

"The celebrated Boyle entertained an idea that perpetual motion might be obtained by means of capillary attraction; and indeed there seems but little doubt that nature has employed this force, in many instances, to produce this effect.

"There are many situations in which there is every reason to believe that the sources of springs on the tops and sides of mountains depend on the accumulation of water created at certain elevations by the operation of capillary attraction, acting in large masses of porous material, or through laminated substances. These masses being saturated, in process of time become the sources of springs and the heads of rivers; and thus, by an endless round of ascending and descending waters, form, on the great scale of nature, an incessant cause of perpetual motion, in the purest acceptation of the term, and precisely on the principle that was contemplated by Boyle. It is probable, however, that any imitation of this process, on the limited scale practicable by human art, would not be of sufficient magnitude to be effective. Nature, by the immensity of her operations, is able to allow for a slowness of process which would baffle the attempts of man in any direct and simple imitation of her works. Working, therefore, upon the same causes, he finds himself obliged to take a more complicated mode to produce the same effect.

"To amuse the hours of a long confinement from illness, Sir William Congreve, has recently contrived a scheme of perpetual motion, founded on this principle of capillary attraction, which, it is apprehended, will not be subject to the general refutation, applicable to those plans in which the power is supposed to be derived from gravity only. Sir William's perpetual motion is as follows:

"Let A, B, C, Plate III, fig. 3, be three horizontal rollers fixed in a frame; *a*, *a*, *a*, is an endless band of sponge, running round these rollers, and *b*, *b*, *b*, an endless chain of weights surrounding the band of sponge, and attached to it; so that they must move together.

"Every part of this band and chain being so accurately uniform in weight that the perpendicular side A, B, will, in all positions of the band and chain, be in equilibrium with the hypothenuse, A, C, on the principle of the inclined plane. Now, if the frame in which these rollers are fixed, be placed in a cistern of water, having its lower part immersed therein, so that the water's edge cuts the upper part of the rollers B, C; then, if the weight and quantity of the endless chain be duly proportioned to the thickness and breadth of the band of sponge, the band and chain will, on the water in the cistern being brought to the proper level, begin to move round the rollers, in the direction A, B, by the force of capillary attraction, and will continue so to move. The rationale is as follows:

"On the side A, B, of the triangle, the weights *b*, *b*, *b*, hanging perpendicularly alongside the band of sponge, the band is not compressed by them, and its pores being left open, the water at the point *x*, at which the sponge meets its surface, will rise to a certain height *y*, above its level; and thereby create a load, which load will not exist on the ascending side C, A, because on this side, the chain of weights compresses the band at the water's edge, and squeezes out any wa-

ter that may have previously accumulated in it; so that the band rises in a dry state, the weight of the chain having been so proportioned to the breadth and thickness of the band, as to be sufficient to produce this effect. The load, therefore, on the descending side, A, B, not being opposed by any similar load on the ascending side, and the equilibrium of the other parts not being disturbed by the alternate expansion and compression of the sponge, the band will begin to move in the direction A, B, and as it moves downwards, the accumulation of water will continue to rise, and thereby carry on a constant motion, provided the load at *x*, *y*, be sufficient to overcome the friction on the rollers, B, A, C.

"Now, to ascertain the quantity of this load, in any particular machine, it must be stated, that it is found by experiment that the water will rise in a fine sponge about an inch above its level; if, therefore, the band and sponge be one foot thick, and six feet broad, the area of its horizontal section in contact with the water would be 864 square inches, and the weight of the accumulation of water raised by the capillary attraction, being one inch rise upon 864 square inches, would be 30 lbs., which, it is conceived, would be much more than equivalent to the friction of the rollers."

"The power of a wheel thus set in motion, may either be applied in the common mode, or by machinery at the end of the axis; or the wheel itself, as in fig. 4, may be made to revolve in a circular cistern of water, of any convenient diameter, being connected by an arm from the centre of the wheel to an upright revolving shaft in the centre of the cistern, so as to be connected with machinery, and produce a similar effect to that obtained by a horse mill.

"It is evident that a constant accumulation of weight on one side of such a wheel as here described, and not on the other, would cause it to roll forward spontaneously in the circular path thus marked out for it; and as this progressive motion must necessarily occasion a considerable undulation in the water contained in the cistern, this undulation will raise the water in front of the wheel some inches above the level of the accumulation caused by the mere capillary attraction. If, therefore, this rise of the waves thus created be four inches above the water's level, the accumulation of water in the sponge on the descending side, including the one inch gained by the capillary attraction, would be five inches in height, and by this means the motive power of a wheel, the original power of which would be 30 lbs., as calculated above, would thus be raised to 150 lbs., which might probably be still further augmented by some mechanical means placed in front of the wheel to increase the agitation of the water.

"Thus if a ripple so created, rose about nine inches, including the capillary ascent, and were repeated every second, the periphery of the wheel would move through a space of nine inches in that period, and revolve at the rate of forty-five feet per minute, with a constant descending weight of rather more than 180 lbs.; which would make the power of such a wheel rather above the power of one man; and if five such wheels were combined, so as to work round one cen-

tre, their united force would be equal to that of a one-horse power steam engine.

"This mode of increasing the power of the revolving wheel in the above figure, by exciting an undulation in the water in which the wheel floats, leads to an application of a similar principle, by which the force of the waves of the sea may be applied with great effect as a moving power to ships and boats, which I shall here, therefore, explain:

"Figure 5, represents the bow of a boat having a wheel of suitable dimensions fixed in front of its stem, by a strong frame work. This wheel is a hollow cylinder closed at the ends, but open all round, with its interior divided into compartments, similar to the Persian wheel, and so disposed that, on a wave rising to any height on the periphery of this circle, all that part of the wave which enters the interior of the wheel or cylinder, shall be retained in the fore-part thereof; while any part of this water, which shall find its way into the after-part of the wheel shall not be retained, but flow out again immediately; so that in case of a wave rising to the full height of the wheel, the whole of the front half of the cylinder shall be fully charged with water, while there would be no counterbalancing quantity in the after-part. The consequence of this, therefore, would be, that a constant revolving force would be kept up by a succession of waves; this force being in proportion to the breadth and diameter of the wheel, and to the height of the wave. Thus, if a wheel be six feet in diameter, and six feet broad, and the perpendicular rise of the waves be also six feet, the maximum charge or moving power of such a wheel would be about 1½ ton, being the weight of water contained in the front half of the wheel, and this, supposing the ship to be in motion, would probably be renewed by succeeding waves, about 20 times per minute. On an average, however, the perpendicular rise of a wave at sea, in lakes, or large rivers, could not perhaps be taken at more than from four to five feet, but this would be somewhat increased by the pitching of the vessel; the revolving power, therefore, of such a wheel, might on an average be estimated at one ton, acting by repeated impulses, similar to that of the common oar or paddle; and supposing the least wave that could be reckoned upon to be from one to two feet in height, so the least probable power, in calm weather, might be taken at 5 cwt.

"The velocity with which the charge of water will descend in these different cases, would, of course, vary. Thus in the first instance, where the wheel has its full charge, the centre of gravity of this water, will be found rather above the horizontal radius, so that every charge would fall through a space of about five feet before it would discharge itself; and supposing therefore, the succession of waves were about 20 in a minute, the moving force of this wheel might be taken at 1½ ton 5-|-feet-|-20, that is to say, 1½ ton moving through 700 feet in one minute; which will be found to be about equal to the power of a ten horse steam engine. In the second case allowing for a proportionate falling off in the succession of waves, and in the velocity of the descent of the water—the power exerted may be consi-

dered as equivalent to the power of a six horse engine, and in the latter case, to that of a two horse power. A similar wheel also might be placed at the stern of the vessel with equal effect; and two or three such wheels might be applied without inconvenience on either side, being mere external appendages, by which means the first power of an enormous propelling force might be attached to a vessel without any internal apparatus, labour, or fuel whatever.

"In larger vessels, it is evident that a wheel of ten or twelve feet in diameter may be used instead of six feet, by which a proportionate increase of power would be gained. Thus the maximum power of a wheel twelve feet in diameter, and six feet wide, would be equal to that of an 80 horse power engine, supposing it to be charged by a repetition of waves at twenty feet per minute, and supposing the centre of gravity of each successive charge to pass through a space of 10 feet before it emptied itself. Two such wheels, therefore, would propel a very large vessel without the slightest loss of stowage, or any expense, beyond the first cost. When moderate velocities only are required, the propelling power may be obtained direct from these wheels by furnishing them with paddles similar to the propelling wheels of a steam boat; but where greater velocities are required, these cylinders should not themselves be furnished with paddles, but should be used merely to drive propelling wheels connected with them by machinery, so as to move at double or treble the rate of these first movers themselves.

"It may be objected to this mode of propelling vessels, that the necessary undulation on the surface of rivers and seas is not always to be found. To this objection, however, it may be most conclusively answered, that in this respect the system of propelling by the rise and fall of waves, is even more general in its application than the present system of propelling ships by the wind; for whenever there is wind there must be waves, and considerable waves are frequently to be met with, even in a dead calm, which is so far a gain in favour of the new system. But there is a still more important circumstance in favour of the new system, which is, that in the latter case, the force is alike applicable to all points of the compass, whereas, the power of sails can only be applied in about twenty points out of thirty-two, in which respect it obtains all the superiority of steam navigation, without its expense or inconvenience. To this also may be added it is much less liable to accident and danger from bad weather, than the system of navigation by sails."

Although we do not believe that a sufficient power can be obtained by the means above indicated, even to overcome the friction of the rollers, and, of course, view all the foregoing calculations as extravagant in the extreme; yet, we do not see that absurdity in the proposition, which characterizes all the projects for obtaining a perpetual motion upon the principles of gravitation; nor indeed does the proposition of the Baronet, include the idea of a perpetual motion, as this term is restricted by those who have written upon the subject. This has been defined to be, *a motion which is supplied, and renewed from*

itself, without the intervention of any external cause. It is probable that, independently of those motions to which the whole mass of the earth is subjected, all the particles of the individual bodies which compose it, are in a state of relative motion; chemical decomposition, and combination; and contraction, and expansion, from a constantly varying temperature, seem fully sufficient to justify this conclusion. We can readily apply this change of length in a metallic rod, to keep a time piece perpetually wound up, and thus preserve it in action until stopped by the wear of the materials; but still this would not be what is intended by a perpetual motion. Galvanism, variations of temperature, the motion of air, or of water, and every other agent extrinsic to the machine, is, therefore excluded.

The impossibility of constructing such a machine, has been repeatedly demonstrated; as, to effect it, would require us to discover a body, which, in one position, possesses less gravitating force than in another; or in other words, which is both heavier and lighter than itself. It is not our intention to discuss this subject, at present, although it is probable, we may take occasion to do so hereafter, as it is one which has claimed the attention, and consumed the time, of many ingenious, and of some very intelligent men.

ENGLISH PATENTS.

To James Yandal, *of Cross Street, in the District of St. John's, Waterloo Road, in the County of Surrey, private person, for his Discovery of an Improvement, or Improvements, on Apparatus for Cooling and Heating Fluids.*

This is an apparatus designed for cooling worts and other hot fluids, without exposing them to evaporation. Utensils employed for this purpose, are generally called refrigerators, and are so constructed, that a quantity of cold water shall be brought in contact with the vessel which contains the heated fluid. But in every construction of refrigerators heretofore used, the quantity of cold water necessarily employed in the operation, greatly exceeded the quantity of the fluid cooled, which, in some situations where water cannot be readily obtained, is a serious impediment and objection to the use of such apparatus.

The inventor has contrived a mode of constructing a refrigerator, so that any quantity of wort, or other hot fluid, may be cooled by an equal quantity of cold water; the process being performed with great expedition, simply by passing the two fluids through very narrow passages, in opposite directions, the result of which is, that the cold liquor imbibes the heat from the wort, or other hot fluid, and the temperature of the hot fluid is reduced in the same ratio.

The patentee commences his specification by saying, "Previously to describing my improved apparatus, I think it right to make a few observations on my discovery, and the general nature or principles

upon which my apparatus is constructed. If two fluids of different temperatures be brought nearly together, separated only by a thin metallic partition, and the surfaces of the two fluids be greatly extended, or thinly spread, compared to their quantity or volume, a rapid interchange of temperature will take place, (assimulated to mixing,) and each of them will acquire the medium temperature in a very short space of time. Now if the two fluids be made to pass each other in opposite directions, through a vessel or apparatus having contiguous passages, so that the temperatures of the liquors may act upon each other, separated by a thin metallic surface, greatly extended, compared to the quantity or volume of the liquor; or in other words, so that two thin sheets or lamina, (as they may be called,) one of hot fluid, the other of cold, be made to act upon each other's temperature, passing in opposite directions, and the thickness of such sheets or lamina of fluid, do not exceed half an inch, and may be as thin as one sixteenth of an inch, the interchange of temperature will rapidly take place, and with nearly the same effect as if they were mixed together; and, if these contiguous passages be of sufficient length, I find, that the hot fluid entering its passage at one end of the apparatus, and the cold fluid entering its passage at the reverse end of the apparatus, there will be very nearly a complete transfusion of heat; and by actual experiment I have found, that wort, or other heated fluid, entering my apparatus at a temperature above 200° Fahr. will pass out at a temperature of 60° Fahr. while the water entering at 56°, will come out at a temperature above 190°; a little heat being necessarily lost by radiation, or the exchange of temperature would be more complete. Having made these general explanatory observations, I proceed to describe my apparatus."

Plate III. fig. 1, represents one form of this apparatus, in this the channels, or passages, run in a zigzag direction; sometimes, when the instrument is made in this form, its position is altered, one of the flat surfaces which form the ends, in the drawing, being placed upon the stand, the other, of course, becomes the top; the plates are sometimes bent spirally, so as to form a convoluted curve. These channels, or passages, are of very small capacity in thickness, but of great length, and of any breadth that may be required according to the quantity of fluid intended, to be cooled or heated.

Fig. 2, is the section of a portion of the apparatus, upon an enlarged scale; it is made by connecting three sheets of copper or any other thin metallic plates together, leaving parallel spaces between each plate, for the passage of the fluids, represented by the black lines.

These spaces are formed by occasionally introducing between the plates, thin straps, ribs, or portions of metal, by which means very thin channels are produced, and through these channels the fluids are intended to be passed, the cold liquor running in one direction, the hot, in the reverse direction.

Supposing that the passages for the fluids are each one eighth of an inch thick, then the entire length for the run of the fluid, should

be about eighty feet, the breadth of the apparatus being made according to the quantity of fluid intended to be passed through it in a given time. If the channels are made a quarter of an inch thick, then their length should be extended to a hundred and sixty feet; and any other dimensions in similar proportions: but a larger channel than one quarter of an inch, the patentee considers would be objectionable. It is however to be observed, that the length here recommended is under the consideration that the fluids are driven through the apparatus by some degree of hydrostatic pressure from a head in the delivery vats above; but if the fluids flow without pressure, then the lengths of the passages need not be quite so much extended.

In the apparatus constructed as shown in perspective, at fig. 1, and further developed by the section fig. 2, cold water is to be introduced at the funnel *a*, whence it passes down the pipe *b*, and through a long slit or opening, in the side of the pipe, into the passage *c*, *c*, (see fig. 2,) between the plates, where it flows in a horizontal direction through the channel, towards the discharge pipe *d*. When such a quantity of cold water has passed through the funnel *a*, as shall have filled the channel *c*, *c*, up to the level of the top of the apparatus, the cock *e*, being shut, then the hot wort, or other liquor, intended to be cooled, may be introduced at the funnel *f*, and which, descending in the pipe *g*, passes in a similar manner to the former, through a long slit or opening, in the side of the pipe *g*, into the extended passage *h*, *h*, (see fig. 2,) and from thence proceeds horizontally into the discharge pipe *i*.

The two cocks *e*, and *k*, being now opened, the wort, or other liquor is drawn off, or otherwise conducted away through the cock *k*, and the water through *e*. If the apertures of the two cocks *e*, and *k*, are equal, and the channels equal also, it follows, that the same quantity of wort, &c. will flow through the channel *h*, *h*, *h*, in a given time, as of water through the channel *c*, *c*, and by the hot fluid passing through the apertures in contact with the side of the channel which contains the cold fluid, and in a contrary direction to that of the cold fluid, the heat becomes abstracted from the former, and communicated to the latter, and as the hot fluid enters the apparatus at that part which is in immediate contact with the part where the cooling fluid is discharged, and the cold fluid enters the apparatus at that part where the wort is discharged; the consequence is, that the wort, or other hot liquor, becomes cooled down towards its exit pipe, nearly to the temperature of cold water; and the temperature of the water at the reverse end of the apparatus, becomes raised nearly to that of the boiling wort.

It only remains to observe, that by partially closing either of the exit cocks, the quantity of heat abstracted from one fluid, and communicated to the other, may be regulated; for instance, if the cock *e*, of the water passage be partially closed, so as to diminish the quantity of cold water passed through the apparatus, the wort or other hot fluid conducted through the other passages, will be discharged at a higher temperature; which in some cases will be desirable, when the refrigerated liquor is to be fermented.

The apparatus constructed upon any of the proposed plans, is calculated to be adapted with great advantage in place of the ordinary worm of a still, its power of cooling, and condensing the vapour, greatly exceeding any other description of refrigerator, and at a much smaller expense of cold water or other cooling fluids, as in this case the wash prepared for distillation, may be passed through the apparatus in place of cold water, and by extracting the heat from the distilled vapour, in the adjoining channel, (which must here be closed,) will condense the spirit therein, and have its own temperature raised at the same time, almost to the boiling point. Under these circumstances, the apparatus will be both a califier, and a refrigerator, and be the means of effecting a great saving of fuel in the process of distillation.

This apparatus must be considered as a great improvement upon the refrigerating worm heretofore used; in consequence of its exposing a surface so much more extended, and by the employment of a stream of cold liquor running in opposition to the course of the condensed fluid, the temperature never varies, the termination of the cooling process being as perfect as the commencement.

When this apparatus is adapted to a steam engine, it causes a very rapid condensation of the steam, by a small expenditure of water, and thereby will in a great degree, dispense with the necessity of the air-pump, (which is a minus power exerted against the engine,) or at least it will so much assist the operation, that a comparatively small air-pump, will be required, and the water heated in passing through the apparatus, may be immediately conducted into the boiler, at a boiling temperature, or nearly so.

The patentee says, "It will be unnecessary to point out all the situations or circumstances in which this apparatus for heating and cooling fluids may be applied, as I have already explained generally its extensive employment in several branches of the arts, and the manner of constructing it, as well as the proportionate dimensions being set out, it only remains to say, that those dimensions are to be enlarged in due proportion, in constructing an apparatus of greater magnitude than those above described; but I wish to observe, that I do not approve, in any case, of making the channels more than half an inch in width."—Enrolled February, 1827.

[*Newton's Journal.*

We inserted a notice of this invention in p. 69, vol. 3, under the head of *Yandal's Califier, and Refrigerator.* We think the account of its excellence there given, is fully justified by the foregoing description, which is much more than can generally be said in similar cases. The succeeding patent is for a modification of the same means; and there is also an existing patent in this country, founded upon similar principles; the specification we have not seen, nor do we know the date of the grant, upon which its validity must, of course, depend.—Editor.

To DOMINIQUE PIERRE DEURBROUCQ, *of Leicester square, Middlesex, Esq. for an apparatus adapted to cool Wort, or Must, previous to its being set to undergo the process of fermentation; and also for the purpose of condensing the steam arising from stills during the process of distillation; communicated by a Foreigner.* Dated May 23, 1826.

IN the apparatus described in the specification of this patent, the smallest of three tubes, of successively decreasing dimensions, is enclosed concentrically within that of the medium size, that, in its turn, is enclosed in the same manner within the largest; which latter, according to the scale of the drawing, is four inches in diameter, and about seven feet long. The middle tube, formed of thin copper, is fluted longitudinally, like the shaft of a column, (or, more precisely, is moulded so as to assume that shape,) and its external projections lie within a circle, which is only half an inch less across than the external tube; while the circle of its internal projections exceeds the internal tube by two inches in its diameter; it is made in joints about three feet in length, in which the flutes do not extend the whole length, but are so managed as to leave a plain rim two inches broad at each end, somewhat less in diameter than the fluted part, and by these plain bands the joints are united together by solder with an overlap of half an inch, so that there will be a plain cylindrical band, three inches broad, interposed between each fluted part, when they are all connected to each other. The internal tube ends in a conical point at each extremity; and the fluted tube is terminated in the same manner; but the external tube exceeds the others in length, so as to leave an enlarged part beyond them at each end, whose shape is not material.

These tubes thus combined, are placed in a position a little declining from the horizontal, at the extremity from whence the liquor is discharged; and beneath them a trough is fixed to catch the water, which is let to flow on the outside one, as will presently be explained; while the whole is supported either by a wooden stand, or by brick work, as is found to be most convenient.

It will be observed that the three tubes, from their above mentioned arrangement, will leave between them all round two concentrical longitudinal cavities; the first bounded by the external tube, and the fluted tube, and the second by the latter and the internal tube. Into the highest end of the first cavity the wort, or must, is let to run by a pipe from the vessel in which it is contained, and is discharged at the other extremity by another pipe, which conveys it to the guile tub, both of which pipes are furnished with cocks, by turning which the flow of the liquor may be made as slow as may be desired for the temperature at which it is to be delivered, which is regulated by a thermometer; a third pipe ascends vertically from this cavity, as high as the level of the top of the vessel, from whence the liquor runs, which serves as a safety pipe, to prevent injurious strains on the enclosing tubes from any accident.

Through the second cavity (between the internal tube and the fluted tube) cold water is conveyed from a reservoir by a pipe that enters its lowest end, while another pipe at its other extremity discharges it away from the apparatus; both these pipes have cocks, by which the water may be made to pass more or less slowly, as will best promote the cooling of the wort, or must. From this second cavity a pipe rises to the level of the top of the water reservoir, to discharge the air from it, when the water is permitted to enter. Also from the hollow vacant space of the internal tube an air pipe ascends through the other two tubes at its upper end, and another pipe passes downwards through them at its other extremity, to permit any water to drain from it, which might casually leak into it from the cavity by which it is surrounded.

The part of the apparatus described is principally employed in cooling the internal surfaces with which the wort comes in contact, or the fluted tube; but it is also expedient to cool the external boundary of the cavity in which it is contained, or the external tube; which is effected by covering it with linen or cloth, kept constantly wet by water, let to flow slowly on it from numerous small pipes, proceeding from the sides of a horizontal pipe of larger dimensions, placed directly above it and parallel to it, which branches off from the cold water pipe that runs from the reservoir to the second cavity; and which after passing over the external tube, turns down into the end of the pipe, through which the wort enters the first cavity, where it is closed by a cock, as are also all the little pipes that branch off from it; the use of which latter cocks, are to make the quantity of water which falls through them on the covering of the external tube, such as will produce the greatest effect, without waste; while the other larger cock, at the end of the supply pipe just mentioned, serves to admit water into the first cavity, when it is required to be cleaned from the substances contained in the wort, which might adhere to its internal surface; to assist which operation, another pipe runs down from it at the farther end, to let the water run off, which, when not thus employed, is kept closed by a cock; but when this cavity is to be thus rinsed, the cock of the pipe that admits the wort into it is to be closed, and the wort which it may contain, is to be let to run off entirely through the pipe at the other end, whose cock is then to be closed, as are also all the small cocks of the branch pipes; after which, on the cock of the supply-pipe and that of the drain-pipe also, at its opposite end, being opened, the water will run through faster or slower, as these cocks are more or less opened, according as will best promote the cleansing of the cavity.

After what has been just stated, the use of the trough underneath the external tube, before mentioned, in catching the water that drops from its cloth covering, will be sufficiently obvious, without farther explanation, and we have now only to add, that a pipe descends from its bottom at one end, to convey this waste water into a drain.

The external tube is made in joints, with flaunches fastened together by screws, in such a manner, that some of the joints may slip over the others, when required; and the pipes that pass through have

screw joints, that permit them to be separated from it without disturbing the rest of the apparatus; by which means all parts of it, successively, may be removed from over the fluted tube, to permit the interstices of this latter to be completely cleansed, when the former method of letting water run through it has not been found to be sufficiently effectual.

The three concentric tubes are to be made somewhat smaller at the lower end, where the cold water enters, which the patentee thinks will cause the latter to have more effect in cooling the wort. Hoops are also directed to be put at the inside of the internal tube at regular intervals asunder, to strengthen it, and notches are made at the bottom of their lowest sides, to let the water pass, that may enter from leakage.

The whole apparatus may be applied for the purpose of condensing the products of distillation, as well as for cooling wort, without any material alteration, by merely uniting a pipe from the still head to that, through which the wort has been mentioned to enter.

The dimensions of the parts of the apparatus, though laid down from a scale in the drawing belonging to the specification, may be varied considerably, without producing any material defect, provided they are not too small for the work, which they are intended to perform; and those of them, which the patentee particularly claims, are the fluted internal tube, and the cloth covering of the external tube, kept constantly wet in the manner which has been explained.

An ingenious mode of distillation by the external application of a gentle stream of water to the still head, has long been in use in East India, of which we first had an account here, from a paper published by Archibald Keir, Esq. in the Transactions of the Asiatic Society, a short time previous to the year 1793, on the method of distillation used at Chatra, in the province of Ramgur.

In the voyage towards the North Pole, made by Captain Phipps, in 1773, a somewhat similar mode was practised in distilling fresh water from that of the sea, by merely keeping the pipe cool, which ran from the still head, by *swabbing* it with a wet mop.

We have always thought, that the principle of condensation, used in those simple methods, deserved farther experiment and improvement, and are happy to perceive that the patentee has endeavoured to attain this desirable object.

Of the apparatus described, we shall only observe that the internal tube seems to us entirely superfluous, being quite vacant of any thing but air; and that, if it were omitted altogether, the larger body of water, which would then be in contact with the inside of the fluted tube, supposing its dimensions remained the same as first directed, would be rather serviceable; particularly as the heat from the inclosed wort would not be prevented from traversing the water sideways, and rising to the top of the fluted tube by the internal tube, as the patentee seems to imagine. [*Rep. Patent Inven.*

AMERICAN PATENT.

To WARREN P. WING, *of Massachusetts, Manufacturer, for an improved Steam engine.* August, 1827.

To all to whom these presents shall come, be it known that I, Warren P. Wing, a citizen of the United States of America, have invented a new and useful improvement in the steam engine, by which it is rendered more simple and compact than heretofore, and in which, the fuel is used with great economy. For which invention and improvement, I claim a patent according to the laws of the United States.

And I the said Warren P. Wing, do hereby declare that the nature of my said invention and improvement, and the manner in which the same may be carried into effect, are fully made known, in the following description, and specification.

The dimensions of my improved engine may vary according to the power which may be required, and its form may be varied according to the taste, or wishes of those who use it. For the sake of facility of description, I will give the dimensions of one which I have made, and which after a fair trial, has been found to answer well in practice.

The furnace is of cast-iron, it is two feet nine inches long, one foot four inches wide, and two feet two inches high; and its appearance resembles the common stove used for warming apartments; it may be made of sheet-iron, or built entirely of brick: when made of metal, it should be lined with fire clay, or bricks. Within this furnace is placed the generator, which consists of a tube of metal, joined by flanches, or otherwise, so as to extend from twenty to forty feet in length, making several revolutions within the furnace, in the manner of the worm of a still; this tube in the engine described, has an internal diameter of about three quarters of an inch, and is made sufficiently thick to sustain the pressure of highly elastic steam.

The cylinder is about three inches in diameter, with a stroke of about eleven inches; this stands upon the furnace, the centre of the upper plate of which is perforated, so as to admit the lower end of the cylinder, to come in contact with the fire, to sustain the heat of the steam. This cylinder is open at top and closed at bottom, in the manner of the old atmospheric engine, it being a single stroke engine. I sometimes intend to use two cylinders, with a lever beam, in which case the power of the engine will be doubled. With the single cylinder, I use a slide, to guide the piston rod and to attach the pitman rods to a fly wheel, in the usual manner.

A forcing pump is placed by the side of the cylinder; from the bottom of this pump, a tube passes through the top of the furnace, and through the fire, to the bottom of the furnace, where it is connected with, and opens into, the lower part of the generator, which it keeps supplied with water. This pump is worked by a connexion with the piston rod of the engine.

The upper part of the tube of the generator, passes out from the side of the furnace, and is bent back, so as to pass into the bottom of the cylinder. This is the only part of the generator, which is exposed to the action of the air, and is of sufficient length only to admit of a safety valve; a throttle valve to regulate the steam, and a cork, or sliding valve to allow it to blow off.

What I claim as new in my engine, is the arrangement of the respective parts so as to prevent the heat from being dissipated, and thus to produce a saving in fuel. This is accomplished, by placing the cylinder so that it may be kept heated by the direct influence of the fire; and by exposing a very small portion of the induction tube, to the cooling influence of the atmosphere.

The above cut, representing one form of this engine, has been sent to us by the patentee. It is without letters of reference, but may be understood from the general description given in the specification.

*On Tortoise-shell, and the mode of soldering, and working it, for various purposes.**

Tortoise-shell, is the shell, or covering, of the Tortoise, or Turtle, an amphibious animal. Of the Tortoise, there are several species; some of them, however, are without a shell. The *testudo imbricata* of Linnæus, a sea-turtle, found both in Asia and in America, is much sought after; not for its flesh, which, though always agreeable to the palate, is sometimes unwholesome, but for its scales, or covering, from which is made a variety of useful and ornamental articles of great beauty.

There are in this shell, three distinct colours; a light yellow, a brown, and a transparent black. Either one, or two, of these, are in general the prevailing colours; they are, however, commonly found in combination. Tortoise-shell is usually transparent, hard, and easily broken. Although, in its texture, it bears a strong resemblance to horn, it is much less tenacious than this article, in consequence of its fibres being united by a smaller portion of unctuous matter. Tortoise-shell is, nevertheless, very malleable, and by the aid of fire, or of boiling water, acquires a considerable degree of ductility; but after being suffered to cool, it retains the form given to it when heated, and becomes as brittle as at first.

Tortoise-shell possesses the singular property, of becoming perfectly united, or soldered, without the use of any foreign material.

The surface of the shells is generally protuberant, and uneven; it is necessary, therefore, in the first place, to flatten them: for this purpose, they are allowed to remain in boiling water until they become flexible; they are then placed in a press, one above another, with flat plates of iron, or of brass, about two lines in thickness, interposed between each shell; these plates must be made warm, and the press is to be screwed down, a little at a time, and the whole suffered to cool completely, before removing them.

The shell may also be straightened, or bent, by means of fire: for this purpose it must be held before the flame of a clear fire, moving it about constantly, otherwise it will become scorched, and be thus rendered entirely useless. There is no risk whatever in allowing it to remain in boiling water, until it is softened; this method ought therefore always to be preferred: besides, fire always affects the colour in some degree, which is never the case with boiling water.

Method of moulding Tortoise-shell.

Whatever may be the form of the mould used, it must be composed of two parts, similar to those used for casting pewter spoons. A small iron press of sufficient size to contain the mould, will also be wanted.

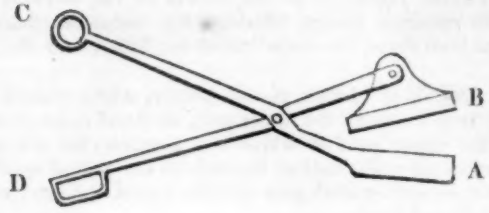
* From the Dictionnaire Technologique.

The shell, after having been prepared in the way before directed, is to be brought to a proper thickness by means of a rasp, a tooth plane, or a coarse float, which the workmen call a grale: the shell is then to be softened in boiling water, and the mould having been previously warmed, the piece is to be put into its proper place, and the pins on one half of the mould, made to enter the holes on the other half; the mould is then to be put into the press, and the screw forced down until a slight resistance is experienced; the whole is then to be put into a vessel of boiling water, when the screw is turned, by degrees, until the two parts of the mould are brought into complete contact. When this is accomplished, the press is to be taken out of the boiling water, and allowed to cool. The mould is to be allowed to remain in cold water for a quarter of an hour, before removing the shell, which will afterwards retain the form it has received.

To solder Tortoise-shell.

To solder two pieces of shell together, the two edges which are to be joined, must be bevelled, or chamfered; taking care that the same inclination be given to both, and that they may perfectly fit each other. They are then to be placed, one upon the other, and when the joint is well fitted, a strip of paper is to be wrapped firmly round them, so as to form three or four thicknesses; the whole should be secured by a piece of thread. A pair of pincers resembling small smiths' tongs, or the pinching irons used by hair dressers, must be heated, the mouth of which must be of sufficient length to embrace the whole joint; these are to be squeezed together, until the shell will bend by its own weight, or by the application of a small force with the finger. The tongs are then to be removed, and when cooled, the piece will be found to be perfectly soldered. Care must be taken that the tongs be not too much heated, otherwise, instead of soldering, they will burn the shell: to prevent this, they must be tried by pinching white paper between them; when they are of such a temperature as to scorch it very slightly, they are then fit for use.

The construction of the mouth of the tongs is a point of great moment, and one to which sufficient attention has not been given; in consequence of this, the operation often fails, or is very imperfectly performed. The two jaws ought to preserve a parallel direction, as they approach each other, in squeezing the junctures of the shell; but as they ordinarily move upon a pivot, it necessarily follows, that they are adapted only to an article of the precise thickness for which they were constructed. The writer was consulted by a workman, who was anxious to obviate this difficulty; a plan was suggested which was found to answer, perfectly, and which has been kept secret by the individual to whom it was communicated; but as he has no claim to the invention, and its utility has been proved, the present is embraced as a suitable opportunity of making it public.



The above figure shows the form in which this instrument may be made; the length of the jaws must be governed by that of the longest joints upon which they are to be used. The lower jaw A, is to have its face even, and to make one piece with the lever A C. The upper jaw B, is attached to its lever D, by means of a pin, as is plainly represented in the figure; this pin forms a pivot upon which the piece B, turns freely. It follows from this construction, that whatever may be the thickness of the interposed piece, it will be pressed equally in every part; and should it even be wedge shaped, or thinner on one edge than on the other, the jaws will adapt themselves thereto.

Care must be taken that the substance of metal be about equal in each jaw, in order that they may retain heat for the same length of time.

Sometimes the shell is soldered by means of boiling water, in which case, the two pieces to be joined, must be so disposed that they may be put into the press, with the joint a little overlapping, and embraced between two pieces of metal: the screw is to be sufficiently tightened, to retain the pieces in their proper situations, when the whole is to be placed in boiling water, and as the shell softens, the screw is to be forced down, and when cold, the union will be complete.

In whatever way the soldering is effected, great care must be taken that the two sides of the joint be perfectly adapted to each other; and they must be left clean from the tool, as the most minute portion of grease, or of dirt of any kind, will defeat the operation; they must not be touched by the finger, nor ought the breath to be directed upon them. When pieces are to be soldered, such parts ought to be joined as accord in colour, and in the distribution of their mottle; as the place of the joint will be thus hidden, or rendered difficult of discovery.

Of making articles of fused Tortoise-shell.

Articles made of fused tortoise-shell, have been known in commerce, for a number of years; particularly, very beautiful snuff-boxes which however, are very rarely transparent. The method of making these, was long kept secret. A very skilful workman in this department, who is now established in Brazil, communicated to the writer, his mode of working, and also repeatedly operated in his presence, without enjoining secrecy.

This workman collected all the refuse of the workers in shell, such as the raspings, filings, turnings, &c. which he obtained for a trifling sum; of these, he made round snuff-boxes in the following manner.

He had moulds of bronze, in two pieces, which passed into each other, like troy weights; the lower part, he fixed in an iron frame or press, in the upper part of which was a screw, for the purpose of pressing upon the upper half of the mould; one pair of moulds served for the bottom, and another pair for the top of the box; of these he had fifty different kinds.

In a furnace constructed for the purpose, was placed a boiler, in the form of a parallelogram, which would contain twenty-four moulds, three in width, and eight in length.

The fragments of shell were all broken into small pieces, of which he took a certain quantity by weight; his great practice having taught him the exact portion necessary to form either the bottom, or the top, allowing for that which was to be taken off in turning, and adjusting, his boxes. This quantity cannot be prescribed, but will soon be learned from practice.

Having put the proper portion into each mould, either in small fragments, or in filings, he placed upon it the counter mould, and forced it down with its screw: when the whole twenty-four moulds were thus prepared, he arranged them in proper order in the boiler, the water in which was previously heated very hot. When the water boiled, he forced down the screw of the first moulds, then that of the second, and in like manner of the whole twenty-four; he then recommenced and proceeded in the same way, keeping the water the whole time in a state of ebullition, until the counter mould could be forced no further, which showed that the space between them was entirely filled with the fused shell.

The water in the boiler is always preserved at the same height, the quantity which is evaporated being supplied by a small stream kept constantly running from a vessel placed above the boiler, and heated to ebullition by the same fire. The heads of the screws of each of the frames, project above the water, in order that they may be the more readily turned by means of a key, or wrench. Each of the twenty-four presses must be braced, or wedged, to keep it from moving when its screw is forced down.

It should have been stated, that a deep groove is made on the counter mould of the bottom of the box, around which a circle of handsome shell is placed, which serves to form the rim. This piece is left rough on its outside, which causes it to become more perfectly soldered to the rest of the shell, so as to form with it one entire piece.

When the whole is cold, the moulds are taken apart and the boxes with their covers, removed; upon the exterior surfaces of these, will be found the designs in relief, figures, historical subjects, or, in fine, whatever device may have been engraved upon the moulds; and nothing more is necessary than to put them into the lathe in order to fit them together, and to smooth and polish them, when they are prepared for sale.

When it is wished to cover with tortoise-shell, articles of value, such as ornamental cabinet work, the shell is not applied immediately upon the wood, but after dressing it, and bringing it to a proper thickness, the under side is covered with a black or red cement made of fish-glue, and lamp-black, or vermilion, ground, and well incorporated; upon this coat of coloured cement, paper is immediately laid, and will adhere firmly. This serves to give a good foundation to the shell, and prevents the glue, or the grain of the wood, from appearing through it. The whole is then glued upon the wood in the manner of Veneer. L.

We have heretofore published several articles translated from that valuable work the *Dictionnaire Technologique;* these were taken from Gill's Technical Repository, but having imported the original work, we shall frequently select and translate such articles as may appear most interesting. Our artisans will thus have an opportunity of learning the difference in the processes pursued in the two countries, and be frequently enabled to improve their own. As we have a very general knowledge of the technical language of the work-shops, we shall be able to give the information in a style which will be familiar to the mechanic; our translations will of course be free, as we shall adopt those modes of illustration which appear best calculated to attain the proposed end. The *Dictionnaire* is not yet completed, having only reached the letter H.

We have repeatedly performed the process of soldering tortoise-shell, and have always done it without any difficulty, by means of boiling water. The shell to be soldered, should be reduced as little as possible in thickness, as in forcing the two ends together, a depression, or groove, is produced on each side of the joint, which, if the shell be thin, cannot be completely turned, or filed out. The only purpose for which we have undertaken this, was to form rims for snuff-boxes; but the most perfect and beautiful specimens which we have seen, have been walking sticks manufactured in France, and in India. These were formed of one perfect tube, which, of course, consisted of strips, soldered together, and afterwards bent round, and united their whole length; this was done so neatly that the place of juncture could only be discovered by narrowly inspecting the occasional abrupt terminations of the coloured clouds in the shell.

We think it probable that a less degree of pressure may answer with the heated iron, than with the boiling water; in which case, thinner shell may be united, but of this we cannot speak from experience. For the mode of polishing, see Vol. 2, p. 236. Editor.

On the beneficial effect of a Lightning Conductor, on a Ship recently struck by Lightning at Sea.

The following is the letter to which Professor Hare alluded in his communication in a former part of this number, it was first

published in the "Liverpool Commercial Chronicle," and has since appeared in several English and American journals.

Ship New York, Prince's Dock, Liverpool, May 11, 1827.

Sir,—I trust, that, although a stranger, I shall find a sufficient apology, in the very uncommon nature of the occurrences herein described, for troubling you with the detail of the following particulars. This ship has been twice struck by lightning on her present voyage from New York. On the 19th of April, our third day out, in the Gulf stream (lat. 33, 9, N., long. 61, 17, W. at noon,) about half past five in the morning, being in our births, we were roused by a sound, like the report of a heavy cannon close to our ears. In a moment we were all out; and the cabin, and all parts of the ship were filled with a dense smoke, having a strong smell of sulphur. From the deck the word was quickly passed, that the ship had been struck with lightning, and was on fire. The consternation which for some minutes prevailed, may be more easily imagined than described. Every one ran on deck with the full impression that the ship was in a blaze. Then all the elements were in violent commotion. It had been broad day, but so dark, so dense, and so close upon us were the clouds, as to produce almost the obscurity of night. There was just sufficient light to give a bold relief to every object in the appalling scene. The rain poured down in torrents, mingled with hail-stones as large as filberts, which lay upon the deck full an inch thick. Overhead blazed the lightning on all sides, accompanied by reports almost simultaneously, thus evincing its nearness. The sea ran mountains high, and the ship was tossed from one wave to another with incredible rapidity. One appearance was particularly remarkable: the temperature of the water was at 74 deg. of Fahrenheit, while that of the atmosphere was down to 48°. This produced a copious evaporation, and caused immense clouds of vapour to rise, which, ascending in columns all around us, exhibited the appearance of innumerable pillars, supporting a massive canopy of clouds. These phenomena are extremely unusual; no person on board having ever witnessed any thing like them before. In all directions might be seen water-spouts, which, rising fearfully to the clouds, seemed actually to present to the eye a combination of all the elements, for the destruction of every thing on the face of the deep. Altogether the scene was of that awful sublimity which baffles description. Amid this scene of impending ruin, when all nature was in the utmost confusion—when nautical science and experience could avail nothing—while an irresistible element was raging about us, and the ship seemed on the very verge of destruction—when, in short, dismay and despair were reflected from every other countenance, nothing could exceed the calm tranquillity of Captain Bennett—nothing could excel the firmness with which the order was given for examining the ship, in expectation of meeting fire below deck—nothing could equal the manner in which every one was encouraged with the hope of security, even beyond what in reason could be expected. Thus I but echo the sentiments of all on board.

But I hasten to my narrative. Some parts of the ship and spars were for a moment on fire, but were quickly extinguished by the rain. The ship was then thoroughly examined, to ascertain whether the electric fluid had penetrated among the combustible part of the cargo below the lower deck. This investigation disclosed the following facts:—The lightning having struck the main royal mast-head, shattered the mast-head, and descending thence, penetrated the deck into one of the store-rooms, the bulk heads and fittings of which are completely demolished. Then separating, one part was conducted by a leaden tube, to the side of the ship, through which it passed out between wind and water, starting the ends of three five-inch planks; another portion from the store-room passing into the ladies' cabin, shivered to atoms the plate of a large mirror, leaving the frame uninjured. From the looking-glass to the piano-forte was an easy transition; it touched the instrument with no delicate impulse, dismounting it, and leaving it out of tune. Thence it passed through the whole length of the after-cabin, and out of the stern windows. Fortunately we were all in our births at the moment. Upon these facts I would venture briefly to remark, that the mast-head was bound by four iron hoops, say from two to three inches wide, and nearly half an inch thick. These attracting the fluid, and being themselves insulated by other less powerful conductors, would naturally at the instant accumulate a large body of the fluid, which, by the violence of its action, burst the hoops asunder, and shattered the mast-head and cap. Into the cabin store-room it seems to have been conducted by a leaden pipe, near the main-mast, under the deck. The quicksilver on the back of the mirror was sufficient to attract it thither, when it would be diffused over the whole surface of the glass, which being the most perfect non-conductor known, was thus shattered into countless pieces. The atmosphere being very moist, the dampness of the cabin floor, for want of a better conductor, might probably aid in carrying it to the windows.

Being all in our births, enveloped in beds and bedding, of non-conducting materials, we reposed in comparative safety, while the deadly bolt acted around us with fierce and resistless energy. Doubtless, a feather-bed is the most safe retreat in such cases. Had it been later in the day, and the passengers about the cabin, the chances are, that it would have been fatal to many of us.

The operation of the second shock was very different from the former, and is most deserving of attention, as furnishing a new instance, in proof of the efficacy of lightning-rods, as a protection at sea. We had a chain conductor on board; but it not being the season to expect much lightning, and the first shock coming on quite suddenly, it was not up at the time. The morning squall was over; it continued, however, to blow fresh all the day, and about noon heavy clouds began to gather on every side, rolling their volumes apparently among the rigging. We had reason to expect more lightning; the conductor was prepared, and Captain Bennett ordered it to be raised to the main royal mast-head. It consisted of an iron chain, having links, one-fourth of an inch thick, and two feet long, turned

in hooks at each end, and connected by rings of the same thickness, and of one inch annular diameter. This chain was fastened to a rod of iron, half an inch thick, and four feet in length, with a point well polished and tapered, in order to receive the fluid with facility; it was secured to the main royal mast, the rod extending two feet above the mast-head, and thence it was brought down over the quarter, and stretched over an oar, protruding say ten feet, from the ship's side, and finally sinking a few feet below the surface of the water.

Dr. Franklin was of opinion that a rod of this size would sustain without injury, the severest shock of lightning. I have been thus minute in stating the dimensions of the chain, for the double purpose of conveying some idea of the force of this shock, and of enforcing the necessity of providing larger conductors. The chain, however, in this instance, performed its office, and it was up in happy time to avert a blow, that, in the opinion of all on board, must have sent this stanch vessel, in an instant, to the bottom of the ocean.

Soon after one P. M. we saw lightning: a little before two, observed a very smart flash; looking at my watch, which marks seconds, I counted four, when the report followed; I felt no alarm, however, having frequently known it to approach nearer without any injury. At two o'clock we were astounded by another shock, like that in the morning: the flash and sound simultaneous. I happened to be in the cabin with another passenger: a ball of fire seemed to dart down before us: at the same moment the glass in the round-house came rattling down below. Those on deck agreed that the whole ship appeared to be in a blaze, from the vividness of the principal flash, which they distinctly saw darting down the conductor, and agitating the water. All parts of the ship, as before, were filled with smoke, smelling of sulphur.

The ship was again thoroughly examined. The conductor had been rent to pieces by the discharge, and scattered to the winds; small fragments of it were found on the deck; in saving the ship, it had literally yielded itself to the fury of the lightning! The pointed rod was found to be fused and shortened several inches, and covered over with a dark coating; some of the links had been snapped off, and others melted. The whole operation was singularly striking, and affords another of those rare cases, where the conductor yielded to the violence of the shock, while it effectually averted the bolt from the object it was designed to protect.

This was a property of the rod of which Franklin was satisfied very early after the application of a theory, which has disarmed the lightning of Heaven! One of the earliest cases which fell under his notice, I believe, occurred in one of the Dutch churches in New York: a chain, connected with the clock, probably, saved the church much damage, but the chain itself was melted.

Mr. Ross, the second officer, was prostrated, and three of the men struck, but none much injured. It affected the polarity of all the compasses, causing them to vary from the true point, and between each other. They gradually assumed a bearing, by which we steered, though still three points out, as we have just discovered. The cap-

tain's chronometer was very materially affected; it usually crosses the Atlantic without varying three seconds, it has now proved to be out of time as many degrees! Curious as are these effects, they are still more interesting in a scientific point of view. Such facts, carefully noted down at the time, afford useful data in the cause of experimental philosophy. Thus collected, they are at our disposal. When it is considered that not one vessel in fifty is prepared with a conductor, cases of this kind ought to admonish ship owners of their utility. Capt. Bennett is determined to go well armed with them in future. It would be well to have one ready to be raised at each mast, in case of emergency; and for the safety of the chain, it ought to be half an inch in diameter.

'We have visited,' says the editor of the Liverpool Chronicle, 'the ship since her arrival, and the traces which remain of the operation of the first shock, together with the concurrent testimony of Captain Bennett and his mates, and the state of the iron rod, and such portions of the chain conductor as have been preserved, which, for the present, may be seen at our office, have served to convince us of the general truth of the foregoing letter, and of the singular good fortune attending the timely application of this simple, but philosophical invention of the admirable Franklin, which no ship should be without. Many additional particulars were recounted to us by Capt. Bennett, which the pressure of other matter, and the shortness of the time remaining to us, prevent us, at present, from repeating. The following circumstance, however, communicated to us by Roskell and Son, chronometer makers, of Church street, Liverpool, are too interesting to be passed over. Captain Bennett's chronometer, after preserving for a considerable length of time, a uniform rate of 7-10ths of a second gaining, and, being nine minutes, forty-two seconds slow of Greenwich time, when the vessel left New York; was found, when compared in Liverpool, to be 24 minutes, 33 seconds fast of Greenwich; and three lever gold watches, belonging to three gentlemen, passengers by the ship, contracted the magnetic power to such a degree, as actually to require the principal part of the steel work to be renewed.'

'Such is the effect,' observes a correspondent, who has transmitted us the above account, 'produced on the steel work in the watches, that they have the power of the magnet, so far as to act the same as the loadstone.'

On an Unfinished Time-Piece, of the late celebrated MR. HARRISON, *in the possession of* JOHN BARTON, ESQ. *of the Royal Mint.* By THOMAS GILL, ESQ.

HAVING been recently favoured with a sight of this time-keeper, which, as above mentioned, was left unfinished by Mr. Harrison, at the time of his death, we think it cannot but be gratifying to our readers, to be furnished with some particulars respecting it.

In the first place, Mr. Harrison has been careful to avoid the em-

ployment of either *iron*, or *steel*, in the construction of the several parts composing it; possibly, from having experienced the liability of those metals to become injured by rust; and therefore he has substituted either brass, gun-metal, tutenague, bell-metal, or even hard wood, in place thereof.*

The arbors are, some of them, made of a composition resembling tutenague, or fine bell-metal, and others are made of gun-metal. The wheels, and frame-plates, are made of fine Flemish brass; and the pallets of the escapement are made of *hard wood.*

The wheels are of a considerable diameter, but made exceedingly thin and slender, so as to press with as little weight as possible upon their necks or pivots, and which pivots are also reduced in thickness as much as possible. The strong pivots of the great arbor are, however, each surrounded with rings of four friction rollers, turning in larger cylindrical holes, made in the frame-plates, of the time-piece, and connected together by flat circular rings, which keep the rollers at a proper distance apart, and revolve with them; in fact, *they are of the very same construction as Garnet's patent friction wheels;* which, however, were patented long after these of Mr. Harrison's were made. The slender pivots of the arbors of the other wheels, each rest, and turn, upon the peripheries of two large, and light, friction wheels.

The slender teeth of the wheels are merely formed in radii lines, with rounded tops; and for pinions, lanterns or rundles, are substituted, with wooden rollers, or cylinders, around them, the rollers having small holes in their centres, which turn upon slender pins of brass, fitted into holes made in the two circular plates, which constitute the frame of each lantern. In the time-pieces at the Royal Observatory at Greenwich, for which Mr. Harrison was rewarded by government, and in several clocks made by him, these wooden cylinders turned upon steel conical points.

The hard wood pallets of the escapement are mounted upon an arbor, having knife-edges at each end of it, resting upon agate bearings; and the pendulum spring was hung between adjusting cycloidal cheeks.

Mr. Barton, we understand, is constructing a grid-iron pendulum for this time-piece; and, when finished, we shall see the result of all this extraordinary provision of Mr. Harrison to obviate friction, and to avoid oxidation.

It certainly furnishes a remarkable instance of the excellence of workmanship, and the care bestowed by Mr. Harrison upon his time-pieces; and we are glad that it fell into Mr. Barton's possession, who has preserved it in perfect order, and has put it into Mr. Wm. Hardy's hands to complete it, and fit it for performing.

[*Technical Repository.*

* The tendency to rust, is not the only objection to the employment of steel in the construction of time-pieces: the permanent magnetism which this metal acquires, is, in chronometers, and other delicate instruments, a troublesome source of error; and although in the larger time-keepers a substitute may be found, we are almost forbidden to hope for it in the smaller.—EDITOR.

Description of an Improvement in Sir Humphrey Davy's Miner's Safety Lamp. By J. Roberts, *of St. Helen's, Lancashire.*

The only real objection to the use of Sir H. Davy's safety lamp for coal miners, is the inferior degree of light that it affords, when compared with that given by a naked candle. This arises from two causes, namely, the necessary obstructions offered by the black wire of which the cage or gauze is composed, within which the lamp is placed, and the casual obstruction occasioned by the adhesion of smoke to the inside of the cage, when the lamp is not carefully trimmed, and of smut, and dust, to the outside of the cage.

To diminish the obscuration occasioned by the first cause, Mr. Roberts proposes that the wire shall be kept bright and polished, by cleaning the cage every night with a soft brush, and the black powder, or smut, which occurs in all coal mines, especially in the neighbourhood of faults: this smut is a pulverized, non-bituminous coal; sufficiently hard to remove the rust from the surface of the wire, without materially wearing the wire itself.

As the lamp is at present constructed, the oil will run out of the cup or receptacle in which it is placed, if the lamp is laid in a horizontal position; an accident which frequently occurs, on account of the lamp being rather top heavy. When this happens, the gauze becomes smeared over with viscid oil, which causes the coal dust floating in the air of the mine, to adhere to it, and in a short time to fill up, more or less, the meshes of the gauze. By merely shaking or tapping the lamp, the dust will not be dislodged; and if the miner attempts to clear his lamp by blowing through the wire gauze, he runs the risk of putting out the light, and after all very imperfectly clears the meshes; there is also perhaps, some risk of forcing the flame through the meshes on the opposite side, and of producing an explosion, if the surrounding air is inflammable.

In Mr. Roberts's lamp, the overflow of the oil is impossible, on account of the dome-shaped cover which surrounds the wick: the dust, therefore, that settles on the gauze, may be dislodged by a mere tap with the finger, or what would perhaps be better, by the application of a small brush similar to that which soldiers carry to clear the pans of their muskets, and which might be attached, by a bit of small chain, to the handle of the lamp.

Plate III, fig. 6, is a section of the lamp *p*, *p*, and wire gauze *q*, *q*; *r*, *r*, a screwed cap, with a hollow dome *s*, it screws into the neck, *t*, *t*, of the lamp: the dome rises a little above the wick-holder *u*, having an opening at top, to let the wick and trimming wire *v*, rise through. This dome serves to catch, and retain, any oil that may spill by shaking the lamp, or knocking it over, thereby protecting the wire gauze, *q*, from being smeared; *w*, and *x*, two locks, the former to secure the cap *g*, and the latter to secure the wire gauze *q*, from being removed.

Fig. 7, a section of the cap and dome *r*, *r*, *s*, separate from the lamp: the wire gauze fits into the cavity *y*, *y*, around the dome *s*: *z*, *z*, two of the four wires which serve to hold the wire gauze.

[*Newton's Journal.*

Description of a bent Lever, and Weight, for Closing Doors.

MR. ADCOCK has invented and communicated to the Society of Arts, an apparatus for closing doors, to be employed instead of spring-hinges. It consists of a bent lever attached to an axle, from which axle, an arm extends, carrying a weight. A small roller affixed to the top of the door, acts against the under side of the bent lever, raising it as the door opens, which lifts the weighted arm; and the force of this weight, acting by means of the bent lever, in an oblique direction against the roller, closes the door, with a force that may be regulated by adjusting the weight upon its arm.

Plate III, fig. 8, represents the apparatus attached to a door, as it would appear when viewed sideways, the door being closed. Fig. 9, represents the same raised, the door being open; *a* is the friction roller affixed to the top of the door; *b*, the bent lever, against which the roller acts. This bent lever is formed something like a ram's horn, being so curved that the roller acts constantly against the under side of it, as the door swings upon its hinges; *c*, is the pivot of the axle on which the lever turns; *d*, is the weighted arm extending from the axle; and *e*, is the weight adjustable upon the arm, and thereby increasing or diminishing the force by which the door is closed.

The particular advantages proposed by the use of this lever are as follow:

1st. Its force may be varied with facility, according to circumstances, so as partly to prevent the inconveniences produced by changes of the wind, and by particular draughts, which occasion the violent jarring of certain doors, the power of whose weights, or springs, upon ordinary occasions are not sufficient to shut them.

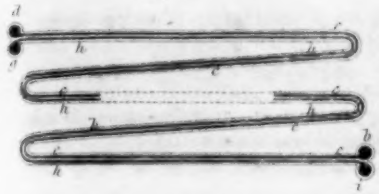
2nd. It is also capable of any disposition of force which may be deemed eligible, or of being so made as to exert its greatest force upon the door while open to any particular angle, causing it to shut with an increasing or decreasing velocity, to latch violently, or merely to close.

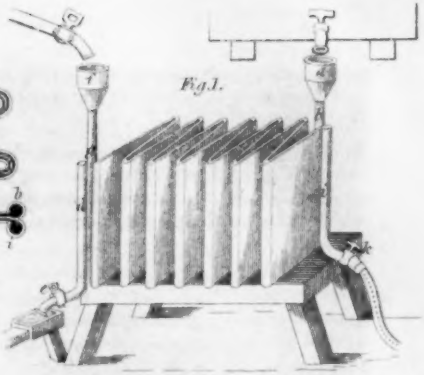
3d. As it acts with but little friction, it will perform its operations unheard, or without causing the least unpleasant or disturbing noise, as is frequently experienced in the modes hitherto adopted.

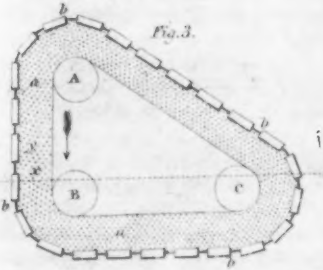
4th. It will be found applicable to any door opening only to a right angle with the post, and may be applied without interfering with the hanging of the door.

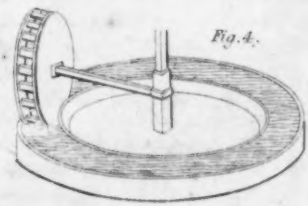
5th. Its construction being extremely simple, the expense will be trifling, and as it is not liable to be deranged, it will continue to act as long as its materials will last.

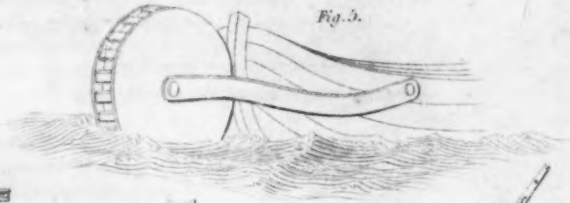
This lever has the desirable quality of holding the door very tight when closed, and thus resisting the wind, and acts gentler the wider the door is opened, so as not to strike with violence against any person following, as will be seen in fig. 9: the distance of the roller *a*, from the fulcrum or axis *c*, is shortest of all when the door is shut, being about one-eighth of the distance of the weight *e* from the same fulcrum; whereas, when the door is open, the position of the roller is directly under the weight *e*; thus with an equal slope throughout

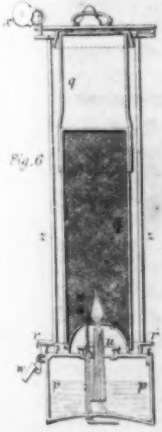


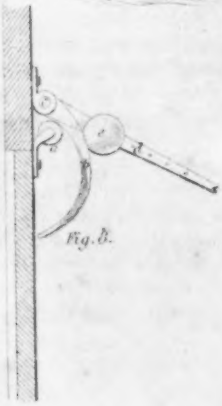


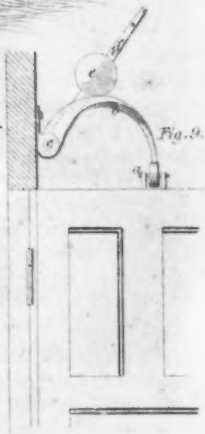












Engd by E.Campbell

the lever *b*, the change of force is gradual, that is, equal in equal times; while by varying the slope, any proportion of force, in any part, can with the greatest ease be obtained, and by a hollow in the end of the lever, farthest from the weight, it may be made to hold the door open if required. The ball is fastened to the arm by a pin, which pin being passed into any one of the holes, along the top of the arm, detains the weight, at the required place. The hole through the weight being wider under the pin than is necessary for the reception of the lever, allows the pin to be raised out of any hole, and transferred to any other at pleasure; the leverage, therefore, may, without difficulty, be adjusted to suit the most windy, or the most quiet day. When there is sufficient thickness in the wall above the door, the whole of the apparatus may be concealed, by letting the door turn upon an axis, which rises through the frame, above the door, sufficiently high to allow the descent of the lever *b*, and it must have a short arm on its top, at right angles with the door, to carry the roller *a*, at its end; the arm will then be parallel with the wall, and concealed within it, and as the arm on the axis and the curved lever must be lessened to suit the thickness of the wall, the weight must be increased, or the arm lengthened, to gain sufficient power. [*Ib.*

Comparative merits of Flint and Percussion Guns.

Sir,—The question respecting the comparative merits of the flint and percussion principles, as applied to guns, never having, I believe, been decided, and a sporting author, who has lately written much on the subject of guns and shooting, having broadly asserted that guns, on the flint principle, had the advantage, I have lately been induced to make trial of the *two* plans, on the *same* gun, and at the *same* time, in a manner which I, as well as many experienced sportsmen to whom I have submitted it, deem very satisfactory; and, as the result may be of interest to many of your readers, you will perhaps favour it with a place in your valuable magazine.

The experiment was made in December last, with *two* guns, and on three successive days. The guns were on the percussion principle, with copper caps, and made by myself. I first stopped up the nipple, or touch-hole, and into the vent-hole I screwed a small pan with a train of gunpowder in imitation of a *flint* gun, and fired my *first* shot in this way; igniting the powder in the pan with a match. I then put in the nipple or touch-hole, and fired the *second* shot with a copper cap; and so changed every shot, from one plan to the other, alternately. The annexed table will show the produce of each shot; the first being No. 1, in the *flint* column, the second No. 2, in the percussion ditto; thus a round of twenty-four shots was fired, as numbered in the tables, 1, 2, 3, 4, 5, &c. being eight shots each day. The strength, or penetration, was also ascertained in the same way; the shot used, averaged 254 to the oz.: the target, 21 by 19 inches, and the distance, 40 measured yards. It will be seen from this statement, that the *percussion* principle was decidedly the best in garnish as well as in strength, being a complete refutation of the above asser-

tion. The kind of wadding used on this occasion, is what I term *woollen paste-board*, in the *flat* form; and I would here observe, while on the subject of wadding, that the *flat* form is decidedly superior to the concave; whether the wadding be made from hempen or woollen paste-board, leather, or felt; this has been proved in a recent experiment, after two days' trial of the different kinds of wadding, before a committee appointed for that purpose.

I am, sir, your obedient servant,

SAMUEL NOCK.

	Garnish.				*Strength.*				
	Flint.		Percussion.		Flint.		Percussion.		
No.	1	78	No. 2	81	Thro'	20	Thro'	27	Sheets of brown paper, wt. 2lb.
	3	80	4	92	—	22	—	28	——
	5	71	6	75	—	28	—	28	——
	7	94	8	62	—	28	—	27	——
	9	97	10	93	—	20	—	25	——
	11	99	12	100	—	20	—	24	——
	13	69	14	86	—	22	—	26	——
	15	100	16	108	—	27	—	24	——
	17	102	18	120					
	19	108	20	107					
	21	85	22	109					
	23	101	24	101					
	12) 1084		12) 1134		8) 187		209		
	Average 90—4		94—6		Average 23—3		26—1		

[*London Mechanics' Mag.*

On the Antiquity of the use of Wheels for Oars, in the manner now practised for propelling Steam Boats.

"During Papin's residence in England, he had witnessed an interesting experiment made on the Thames, in which a boat, constructed from the design of the Prince Palatine, Rupert, was fitted with *revolving oars*, or paddles attached to the two ends of a long axle going across the boat, and which received its motion from a trundle working in a wheel turned round by horses. The velocity with which this horse-boat was impelled was so great, that it left the king's barge, manned with sixteen rowers, far astern in the race of trial.

"The use of wheels for oars is very ancient. In some very ancient MSS. extant in the king of France's library, it is said the boats, by which the Roman army under Claudius Caudex was transported into Sicily, were propelled by wheels moved by oxen. And in many old military treatises the substitution of wheels for oars is mentioned.

"Robert Valturius gives a view of two gallies moved by *wheels* instead of oars: the first diagram shows *five* wheels on each side of the vessel; each pair are connected by a separate axle running across the boat, this axle is formed like a crank in the middle of its length, and the five axles are connected together by a rod, or a rope, so that

all their movements are simultaneous. The second diagram has one wheel at each side of the galley; these are also connected by an axle running across the boat, as shown in the figure: he gives no details, but he merely mentions, that the velocity of these boats will be greater than if they were propelled by oars. *De Re Militari*, lib. xi. p. 2. Veronæ, 1472.

"Pancirollus, a celebrated professor at Padua, in 1587, saw an ancient bass-relief, which represented a galley with three wheels on each side of a boat, turned by three pair of oxen. And he observes, that they would have a greater velocity than the swiftest three-decked gallies. *Res Memorabiles*, p. 127. Ambergæ, 1599.

"An old English writer on military subjects says: 'And furthermore you may make a boate to go without oares or sayle, by the placing of certain wheeles on the outside of the boate, in that sort, that the armes of the wheeles may goe into the water, and so turning the wheeles by some provision, and so the wheeles shall make the boate goe.' *Invention, or Devises, by William Bourne*, p. 15. London, 1578.

"Edmund Bushnel, a shipwright, describes 'a mode of rowing ships by heaving at a capstan, useful in any ships becalmed.' He connected the oars on each side of the vessel together, and he gave them the alternate backward and forward movement, by attaching the connecting pieces to ropes which were wound and unwound by the capstan. *Compleat Shipwright*, p. 56, fourth edit. 1678.

"*A horse 'tow-vessel'* was used at Chatham in 1682. It was constructed with a wheel on each side of the vessel, connected by an axle going across the boat, and the paddles were made to revolve by horses moving a wheel, turning by a trundle on the axle. It drew but four and a half feet of water, and towed the greatest ships by the help of four, six, or eight horses: the wheels were permanently fastened to the side of the boat; the capstan to which the horses were yoked, was not that of the boat. *Savery's Navigation Improved*, p. 13, London, 1698. This, probably, is the identical vessel constructed from the design of Prince Rupert."

[*Stuart's Anecdotes of Steam Engines.*

Food for Horses.

A PRACTICE is becoming general in Silesia of feeding horses with bread, made by taking equal quantities of oat and rye meal, mixing it with leaven or yest, and adding one third of the quantity of boiled potatoes. To each horse is given 12lbs. per day, in rations of 4lbs. each. The bread is cut into small pieces, and mixed with a little moistened cut straw. It is stated that by this means there is a saving in feeding seven horses "of 49 bushels of oats in 24 days, while the horses perform their common labour, and are much better in look, health, and disposition."

Another improvement in the feeding of horses, which has just been announced by the Rev. W. Evans, of Llandefeilog, Carmarthenshire, consists in the substitution for hay and corn, of cut straw and pota-

tos, or straw, chaff, and pounded furze mixed, wetted with salt water. The process of preparing it is as follows; "Let a tub full of fresh water, with an egg in it, be impregnated with as much domestic salt as will cause the egg to rise and float on the surface, that being the criterion of its saltness, being equal to that of sea water. The provender being put into a wicker basket, and placed on the tub, pour the salted water upon it, in quantity sufficient to wet the whole mass, and when it shall have done filtering through it, give it to the horses. The salted water will not only moisten and sweeten the food, but also operate as a most efficient alterative to purify the blood, purge all gross humours, prevent the increase of worms, and all painful attacks from those troublesome vermin. Horses fed in this manner will work well, and will be fit for all sorts of work. A man cuts with one knife machine, in four hours, enough of wheaten straw to last nine horses for twenty-four hours."

Diamond Microscope.

[From the Quarterly Journal of Science.]

Of all the various substances furnished, either by nature or art, the diamond seems to be that most pre-eminently calculated to form small deep lenses for single microscopes, possessing a most enormous refractive power, combined with a low dispersive one, together with a very little longitudinal aberration. Mr. Andrew Pritchard, 18, Picket street, Strand, has succeeded in forming a very thin double convex lens, of equal radii, and about 1-25th inch focus, from a very perfect stone of the finest water. Its polish is very beautiful, and by its strong reflective power, at once informs us of the peculiar and invulnerable material of which it consists, while the large angle of aperture which it bears, attests the faintness of its spherical and chromatic aberration. It appears from experiment, that, though the refractive power of different stones varies considerably, if a diamond and a piece of plate-glass are ground in tools of the same figure and radius, the magnifying power of the former will surpass that of the latter, at the rate of eight to three; so that if the power of the glass microscope should be 24, that of the diamond one will be 64! What a lift does this give us in the construction of deep single microscopes! If a diamond was ground in the same tools which had produced a glass lens of 1-75th of an inch focus (which it would be very possible to do, and which we believe Mr. P. would undertake to effect,) it would turn out about 1-200th of an inch focus; but this is by no means the only valuable property it would possess; for Mr. G. Francis has been at the pains of calculating the value of the spherical aberration of a plano-convex diamond, with its curvature exposed to parallel rays, and finds it only 0.949 of its *thickness*, while that of glass is known to be 1.166, *cæteris paribus*. This difference would be very considerable, even if the thickness of a glass and diamond lens, of the same focus and diameter, was the same; but this is, of course, far from being the case, owing to the immense refraction of

the diamond, which gives a very short focus, with a very shallow curve, and proportional thinness. If a diagram is made of the curve of any two lenses of the *same* penetrating and amplifying power, formed of glass and adamant separately, it will at once show what their spherical aberration amounts to; being enunciated in terms of their thickness, as stated above, and which, of course, is the same, whether they have their curved surfaces exposed to parallel rays, or their flat sides to divergent ones, from a radiant point in their focus, when used as magnifiers. If we select a hemisphere of glass, having its aperture equivalent to its focus, which is absolutely necessary for exhibiting certain test objects, and calculate the longitudinal aberration of a diamond of the same power and calibre, it will be found less than one sixth of that of the glass! Again, the chromatic aberration of the adamant is very little more than that of a drop of water of the same radius, which is scarcely felt at all, when the stone is used only as a single microscope; so that we thus obtain a kind of *natural aplanatic lens*, capable of being carried to an enormous power, which is, in fact, the very *beau ideal* of the single microscope, necessarily the most perfect instrument of all, when divested of aberration. Of all the improvements in microscopes which have been originated by Dr. Goring, this is, perhaps, the most important, and the most likely to extend discoveries in minute nature.

As many individuals have chosen to doubt of the possibility of working diamonds into spherical curves, Mr. Pritchard will be proud to exhibit his instrument to amateurs of microscopic science.

Mirage, in Persia.

The wonderful effects of the mirage, and the phenomena it produces, have frequently been the theme of admiration with travellers; but it is almost impossible to conceive the extent to which these prevail upon the wide and level plains of these countries, when the air, in a state of rapid undulation, causes every object near the surface, to tremble into forms as uncertain and evanescent as the eddies that produce them. A distant mountain, in the space of a minute, will assume, first, perhaps, the form of a lofty peak; this, after rising to what appears a prodigious elevation, will thicken at the top, and spread into that of a large mushroom, with a slender stalk; the top will then split into several spires, and then all will join into a solid table shape. This is extremely puzzling to a surveyor, who depends upon the peaks of mountains, as objects from which to form his triangles; for he may be thrown many degrees out of the true line, by trusting to an observation made under such circumstances. In other instances, a mud-bank, furrowed by the rain, will exhibit the appearance of a magnificent city, with columns, domes, minarets, and pyramids, all of which flit as you approach; till, to your utter confusion, they dwindle into a heap of earth, perhaps not ten feet high. Numberless have been the mistakes made, of asses with boys on them, for elephants and giants, or well mounted troops of cavalry; sheep

and goats, for camels and dromedaries; and the smallest bushes, for fine forest trees. There is sometimes great beauty, and much that is amusing, in the variety of phenomena produced, but they not unfrequently involve the weary traveller in great disappointment.

[*Fraser's Travels.*

Analysis of a Powder, which is sold in Paris under the name of Colour, and used in giving trinket gold, the colour of fine gold.

Cupidity and ignorance, have often issued in commerce, under different names, a multitude of more or less noxious substances, to which extraordinary properties have been attributed; and the credulous public, having no suspicion of the dangerous properties which these substances often possess in a very high degree, and according to which they exert a specific agency, are frequently exposed to the most serious accidents. Secret preparations of this kind, cannot be too well made known, nor can too much publicity be given to their composition, and the analysis that may be made of them; the knowledge of the results of which, may be so eminently useful to society. The powder which the trinket-manufacturers used to apply for the purpose of colouring gold, was composed of marine salt, nitrate of potash, and alum; but, for some time back, another substance has been vended, the composition of which, is different. This powder is of a dirty white colour, having a tinge of red, its taste is salt, and like that of common sea salt, but it leaves a disagreeable metallic taste in the mouth; and it sensibly attracts moisture from the air. Its analysis has furnished the following results. Twenty grammes of it have yielded,

Of pure white oxide of arsenic - -	2,135
Alum, with a base of potash, - - -	4,190
Marine salt, - - - - - - -	13,560
Oxide of iron and argil, - - - -	0,115
	20 grs.

If this powder be really used for colouring gold, as I have been assured, the oxide of arsenic, I should think, can have no effect in that way.—*M. J. L. Casaseca.*

Note by M. D'Arcet.—I have several times had occasion to examine the saline composition known under the name of *colour*, which is employed by the toymen, for giving to trinket gold, the beautiful yellow colour of fine gold. The following is the result of my analysis, in round numbers:

Saltpetre, - - - - - - - -	40
Alum, - - - - - - - -	25
Sea-salt, - - - - - - - -	35
	100

I was not aware that any change had been made in the composition of this mixture. If the powder, examined by M. Casaseca, be now used for colouring gold, it can only have been adopted of late, and since fashion has introduced the taste, and rendered necessary the employment of variously coloured alloys of gold with silver, copper, iron, antimony and platina. M. Casaseca's observations appear to me to be very important, and will, without doubt, induce authorities to adopt measures of administration for obliging the persons who prepare, vend, or employ the new composition in question, to employ all the necessary precautions against the danger arising from the use of a mixture containing so much oxide of arsenic.

[*Annales de Chimie, et de Physique, Mar.* 1826.

Opposite effects of a change of density of the air, as affecting the going of a Clock.

Davies Gilbert, Esq. M. P. a short time ago, published some ingenious investigations on the vibration of pendulums, and showed, that on a change of an inch, in the height of the barometer, an astronomical clock ought to change its rate, in consequence of the alteration in the buoyancy of the air, by two-tenths of a second a-day. Having applied to Mr. Pond and Dr. Brinckley to examine this point, he was surprised to find that they had discovered no such change. On reconsidering the subject, he finds a cause which, before, he had supposed too small to have any effect, almost exactly counterbalancing the effect of the change of buoyancy. This cause, is the alteration of the arc by the altered resistance of the air. He remarks, "it is an extremely curious circumstance, that, without any reference to the attainment of this balance between opposite disturbing causes, our best clocks should have been fortuitously made to vibrate very nearly in the arc which reduces them to equality." For the mathematical investigations and tables illustrative of this singular coincidence, we must refer to the Quarterly Journal of Science for October.

[*Dublin Philosophical Journal.*

The Bark of the stem of the Pomegranate, a specific in the cure of Tænia, or Tape Worm.

P. Breton, Esq. says, "I have repeatedly put to the test of trial in cases of tænia, with uniform success, the dried bark of the stem of the pomegranate shrub, both in decoction and in powder, without exciting any other sensation than those which arise from the fresh bark of the root of the plant. I have also ascertained by frequent trials, that the virtues of the bark may be preserved several years; a circumstance favourable to its transmission to Europe. Some bark of the stem which I have had upwards of four years, packed in a deal box, I have recently tried in several cases of tænia with perfect success; so that I have no hesitation whatever in recommending this drug not only as a safe, but as a perfectly certain remedy for expul-

sion of tænia. This drug is equally efficacious in expelling from the lower animals (especially dogs,) tænia, to which they are particularly subject in this country. To full grown dogs may be given the same dose as that taken by adults. The powder mixed with butter or minced meat, is as good a form as any; some dogs will of themselves eat it when prepared in this manner. The powder may also be given in balls, or the decoction may be substituted with equal effect. We are indebted, it seems, for our knowledge of this invaluable remedy for the tape worm to a mussulman fakeer, named Azimshah, who, in 1804, having relieved in a few hours, Mr. Robert Home, of Calcutta, of a tænia which measured 36 feet in length, was prevailed on by a reward of two gold mohars, to disclose the secret.

[*Trans. Med. Soc. Calcutta.*

Sympathetic Ink.

The following application of a modern chemical discovery, has never before been communicated to the public, and affords a sympathetic ink very far superior to any, as yet, in use. Dissolve a small quantity of starch in a saucer, with soft water, and use the liquid like common ink: when dry, no traces of the writing will appear on the paper, and the letters can be developed only by a weak solution of iodine in alcohol, when they will appear of a deep purple colour, which will not be effaced until after long exposure to the atmosphere. So permanent are the traces left by the starch, that they cannot, when dry, be effaced by Indian rubber; and in another case, a letter which had been carried in the pocket for a fortnight, had the secret characters displayed at once, by being very slightly moistened with the above mentioned preparation. [*New Monthly Mag.*

Notice of "Hale's Introduction to the Mechanical Principles of Carpentry."

An octavo volume, of about 180 pages, under the above title, has been just published, by Richardson & Lord, of Boston, and P. Sheldon, of Gardiner, Maine. The work is written by Mr. Benjamin Hale, principal of Gardiner Lyceum. It is divided into two parts, the first treats of the *strength and stiffness of timber*, and the second of *statics applied to constructions of timber*. We have perused this volume with much satisfaction, and recommend it as calculated essentially to aid the operative carpenter in the prosecution of his business. It does not pretend to much originality, and had it done so, we should have thought it a very unfavourable symptom; much valuable matter has been published upon this subject, but it is usually contained in works which are inaccessible to the ordinary workman, on account of their cost; and which to most of them wear a repellent aspect, in consequence of the extensive use of algebraic formulæ: for however desirable it may be, and is, that the mechanic

should be well acquainted with the arithmetic of signs, the time is not likely soon to arrive when this knowledge will be general. To the work before us, neither of these objections can be urged.

Mr. Hale has made free use of Tredgold, Robison, Barlow, and others, either copying them verbatim, or moulding them so as to suit his purpose, and has thus produced a work, which, whilst it is moderate in cost, is neat in its execution, and valuable from its matter. The subjects are illustrated by 82 figures, executed with remarkable neatness. We are informed in a note that "The cuts in this book were made by Mr. L. T. Jackson, of Brunswick, Maine, of *brass rule*, according to a method recently invented by him. These are the first specimens which have appeared in any publication, and this note is inserted, in justice to the author of an invention, which will probably be of considerable importance."

We should be much gratified, should it suit the inventor's views, to receive a description of his mode of procedure, as, should it abridge the labour, it will often be preferred even where wood engravings can be procured, and will be of extensive utility. We have made some essays of the kind, but found the labour too great, and, when executed, the effect was very inferior to some of those produced by Mr. Jackson.

List of Patents granted in the United States, from March 23d to April 10th, 1827.

FOR INVENTIONS AND IMPROVEMENTS.

In the method of pumping water out of Ships by manual power; Thomas Brownell, N. York, March 23.

In an improved cooking stove; Joseph R. Page, Philadelphia, March 24.

In a machine for pressing, and for lifting, heavy bodies; Samuel Andrews, Bridgetown, Cumberland county, Maine, March 24.

In the twin plough; Noble G. Cryer, Wentworth, Rockingham county, N. Carolina, March 24.

In the churn; S. L. Bagley, Hillsdale, Columbia county, N. York, March 24.

In the method of grinding and polishing hard substances; Benjamin Green, Windsor county, Vermont, March 27.

In the horse rake; Jeremiah Baily, Philadelphia, March 30.

In the manufacture of tobacco; John Allen, Jr. and Charles Geoghegan, Richmond, Virginia, April 3.

In making watch keys; John S. Davis, Providence, Rhode Island, April 3.

In cutting wood into a circular form for the sides of tubs, buckets, &c.; Jeremiah Baily, Philadelphia, April 7.

In the machine for grinding apples; Constant H. Wicks, Paris, Oneida county, New York, April 9.

In making hominy; Robert Campbell, Martinsburg, Virginia, April 9.

In the paddle wheel of a steam boat; Robert L. Stephens, Hoboken, New Jersey, April 10.

French Patents granted in the third quarter of 1826.

A. Poussard, Toulouse, for an addition to the quadrature of a clock —15 years.

M. Bailly, Paris, for a process wherewith every individual may take himself the measure of his coats—5 years.

N. H. Manicler, London, for a substance to manufacture wax candles—15 years.

V. M. Fichet, Estrepilly, for a machine to cleanse corn—5 years.

F. Lacarriere, Paris, for a regulator in the emission of gas—5 years.

Viscount de Barras du Molard, Valence, for a new system of bridges—5 years.

A. E. Jauge, Paris, for additions to the apparatus for extracting salt from liquid—15 years.

A. N. Lhomond, Paris, for additions to his chimneys called "Parisienne"—15 years.

Anspach and Valentin, Metz, for an oil-mill—15 years.

O. Napier, London, for a system of canal locks—10 years.

G. Busnoir, Lyons, for new gallooks—5 years.

J. Collier, Paris, for a power-loom, with intermittent motion—15years.

M. Lorillard, Nuits, for a machine to prepare flax or hemp—15 years.

Joh. Knoules, London, for a new system of constructing masts —10 years.

P. Revon, Paris, for additions to a locomotive carriage engine—10 years.

Hue, Paris, for making picture-borders—5 years.

J. Lenobbe, Paris, for a wool-combing machine—5 years.

S. Vallee, Paris, for manufacturing cotton twist, called "cordonnet-cotton"—10 years.

L. C. F. Coninck, Paris, for a new process of creating steam—15 years.

A. Bouchet-Viors, Montpellier, for a distilling apparatus—10 years.

Frimot, Landernan, for a rotative steam-engine—15 years.

D. Levique, Alencon, for improvements in piston guns—5 years.

L. F. Dorrielle, Pellusin, for a substance as a substitute for the gall-nut—15 years.

L. Richard, Paris, for a process to propel boats up a river—15 years.

Joanne Freres, Dijon, for a machine to carry boats up a river by its own current—15 years.

V. Mouton, Paris, for manufacturing bars, &c. covered with metal —5 years.

Granted in the last quarter of 1826.

Stock, Samuel, Paris, for a process to print or paint on both sides of silks, cottons, &c.—10 years.

J. B. P. Nichols, Paris, for an apparatus to cool beer—10 years.

P. J. Debezis, Paris, for a distilling apparatus—10 years.

J. A. Cambaceres, Paris, for the use of Stenric acids, in the fabrication of oxygenated wax lights—15 years.

S. Frank, Amsterdam, for a blacking called the *cordova lustre*—5 years.

Messrs. Lemoine and Meurice, Paris, for a machine for mixing colours—15 years.

Allnand, Brothers, Limoges, for a method of grinding by water, to reduce into an impalpable powder, and convert into paste or enamel, all flinty, earthy, and other metallic oxyde substances—10 years.

R. M. Joly, Paris, for water-proof boots and shoes—5 years.

F. P. Lebourlier, Paris, for a method of taking off the husk of black pepper, and whitening it—5 years.

J. Laborde, Paris, for a mechanical apparatus for evaporating, concentrating, thickening and clarifying liquids, or all liquified substances—5 years.

C. E. M. Bereche, Paris, for a lighter steam-boat than those hitherto built—15 years.

A. B. Gensoule, Bagnols, for a method of heating the pans, for winding off silk from the balls, with economy of fuel—10 years.

S. Berard, and J. Wilkinson, for a bobbin and its carriage for spinning, lengthening, and twisting raw silk, flax, hemp, wool, cotton, and such like—15 years.

P. Arnut, Rochefort, for an economical chimney, free from smoking, and for a machine for sweeping chimneys—5 years.

A. Rivaux, Lyon, for a weaver's shuttle, in which the cane experiences a retrograde motion every time it is thrown, by which the portion of woof over-wound, returns upon the cane—5 years.

L. D. Davenne, Paris, for a moveable cushion for billiard tables—15 years.

P. Masnyac, Lyon, for a method of preparing hats with chickens' feathers—5 years.

LIST OF PATENTS IN ENGLAND.

Which passed the Great Seal, from March 2d, to March 27th, 1827.

To Joseph Frederick Ledsam, of Birmingham, merchant, for his having invented an improvement for purifying coal gas, by means not hitherto used for that purpose—Sealed 2nd March.

To Nathan Lucas, and Henry Ewbank, of London, merchants, for their having invented an improved process to be used in the dressing of paddy, or rough rice—10th March.

To Lemuel Wellman Wright, of Surrey, engineer, for his having

invented certain improvements in the combination and arrangement of machinery for making metal screws—17th March.

To Benjamin Rotch, of Furnival's Inn, in the city of London, esq. for his having invented a diagonal press, for transferring perpendicular to lateral pressure—22nd March.

To James Stewart, county of Middlesex, piano-forte maker, for his having invented certain improvements on piano-fortes, and the mode of stringing the same—22nd March.

To James Woodman, of Piccadilly, perfumer, for his having invented improvements on shaving and other brushes, which improvements are also applicable to other purposes—22nd March.

To Jacob Perkins, of Fleet street, in the city of London, engineer, for his having invented certain improvements in the construction of steam engines—22nd March.

To Matthew Bush, of Dalnonach Print Field, near Bonhill, near Dunbarton, North Britain, calico-printer; for certain improvements in machinery, or apparatus for printing calico, and other fabrics—March 27, 1827.

NOTICES.

To Correspondents.—Mr. Malin's furnace, and Mr. Stott's coal-boats, will appear in our next, as the lost drawings have been recovered, and the cuts are completed.

Essays on Lithography.—We are compelled to issue the present number without a continuance of this series of essays, in consequence of the *Journal des Connaissances*, not having yet come to hand. They will undoubtedly be resumed in our October number.

Erratum—In Mr. Shaw's paper on gunpowder, in our last number, p. 129, 15th line from the bottom, for 'less *durable* than formerly,' read 'less *desirable* than formerly.'

Mr. Perkins's Engine.—Some very satisfactory information on the subject of this engine, came to hand after our last form was made up: this will appear in our next, and we hope that an expected communication from Mr. Perkins himself may also arrive in time to accompany it.

Subscribers in New York are particularly requested to pay the amount of their subscriptions to Mr. James M. Campbell, No. 9 Arcade, who continues to be the agent for this Journal. A part of the numbers for August, were delivered by a friend to the publisher, during the period of the temporary interruption of Mr. Campbell's business, in consequence of the dissolution of his partnership with Mr. Hart. Should any unfavourable impression have been made by this circumstance, it is hoped that the present notice will suffice for its removal.